CHOATE

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September 13, 2006

BY HAND

Mary L. Cottrell, Secretary
Massachusetts Department of Telecommunications and Energy
One South Station, 2nd Floor
Boston, MA 02110

Re: D.T.E. 06-70 - Investigation by the Department of Telecommunications and Energy on its own motion pursuant to Chapter 123 of the Acts of 2006, § 115, to establish the maximum rates and fees to be charged by the Massachusetts Turnpike Authority to wireless providers for the placement and use of wireless attachments in the central artery tunnels

Dear Ms. Cottrell:

Pursuant to D.T.E.'s August 11, 2006 Vote and Order to Open Investigation and its September 6, 2006 Procedural Notice, enclosed for filing in the above-referenced matter is the Massachusetts Turnpike Authority's proposal for rates and fees to be charged for wireless attachments in the central artery tunnels.

Please note that, in accordance with the Procedural Notice, I have served by email and first class mail copies of the enclosed on all parties named on the attached Service List.

Kindly acknowledge receipt of this submission by date-stamping the enclosed copy of this letter and returning it to my awaiting messenger. If you have any questions, please do not hesitate to call me. Thank you for your assistance.

Very truly yours,

Johanna Schneider

Enclosures

cc: Service List

4122879v1

SERVICE LIST – DTE 06-70

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THE COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF TELECOMMUNICATIONS AND ENERGY

In the Matter of: Investigation by the Department of Telecommunications and Energy on its own motion pursuant to Chapter 123 of the Acts of 2006, § 115, to establish the maximum rates and fees to be charged by the Massachusetts Turnpike Authority to wireless providers for the placement and use of wireless attachments in the central artery tunnels.	D.T.E. 06-70

PROPOSAL OF THE MASSACHUSETTS TURNPIKE AUTHORITY

In accordance with the Department of Telecommunications and Energy's ("DTE") August 11, 2006 Vote and Order to Open Investigation (the "Vote and Order") and in furtherance of Section 115 of Chapter 123 of the Acts of 2006 (the "Legislation"), the Massachusetts Turnpike Authority (the "Authority") hereby submits this proposal (the "Proposal") for establishing rates and fees to be charged for wireless attachments in the tunnels of the central artery (as defined in the Legislation).

Introduction

The Vote and Order set an initial deadline of September 1, 2006 for the Authority's submission of the Proposal. The Authority on August 29, 2006 moved DTE to extend the filing deadline to September 20, 2006. See Massachusetts Turnpike Authority's Motion for Rescheduled Filing Deadline (the "Authority's Motion"). As set forth in the Authority's Motion, and as reiterated by counsel for the Authority at the August 30, 2006 procedural conference in this matter, due in large part to the complexity and novelty of the information required by the Vote and Order, the deadline for submitting the Proposal established in the Vote and Order did not provide the Authority sufficient time to prepare a complete response to DTE's request. As noted in the Authority's Motion, the earliest that the Authority could potentially provide an adequate response was September 20, 2006. DTE denied the Authority's Motion and set a deadline of September 13, 2006 for submission of the Proposal.

The Authority has endeavored to provide complete information in this Proposal where possible; however, for the reasons articulated in the Authority's Motion, due to the complex analysis required by the Vote and Order and the abbreviated time frame allowed for its preparation, much of the information presented herein is preliminary. The Authority therefore reserves its right to supplement or amend this Proposal as provided by 220 CMR §1.06(6)(c)(5).

The Authority further notes that it has not yet retained any "experts" to assist in the preparation of this Proposal; rather, all information set forth herein was provided by Authority and/or CA/T Project staff and consultants involved in the Project. As a result, no "expert testimony" is currently available in support hereof.

Finally, the Authority notes that its participation in these proceedings, including without limitation its submission of this Proposal, is subject to a reservation of all of its respective rights and remedies, preemption by federal law, and otherwise subject to any approvals required by applicable federal, state, or local laws.

Background

Beginning in May 2001, Authority staff commenced its efforts on the so-called "CA/T Wireless Project" by holding informational interviews and discussions with each licensed national wireless communications provider (collectively, the "Carriers"). These meetings were designed to gauge each Carrier's interest in providing wireless telephone service in the I-90 and I-93 tunnels and to obtain the Carriers' thoughts on a structure to best implement the CA/T Wireless Project for all interested parties. At these meetings, the Carriers communicated a strong preference that the Authority should engage a neutral host provider to construct and maintain a carrier neutral shared antenna wireless telephone communications system (the "System") for the Carriers.

Based upon this information, Authority staff determined that the optimal structure for the CA/T Wireless Project would be for the Authority to separate the construction and maintenance component from the rental component. More specifically, the Authority would contract separately with a neutral host installer though a lease of space in which the System would be constructed in the I-90 and I-93 tunnels. Then separately, the Authority would contract directly with each interested Carrier who in return for the right to operate in the System would (a) pay rent directly to the Authority and not through any "middleman", and (b) pay to the Authority its pro rata share of the costs to construct the System which in turn would be paid by the Authority to the System vendor under its lease.

Pursuant to a Request for Proposals dated July 10, 2002 (the "Vendor RFP"), the Authority sought a vendor to construct the System consistent with the above structure. The Vendor RFP contemplated that the designated party (the "Selected Vendor") also would maintain the System at the expense of the Carriers participating in the CA/T Wireless Project. The Vendor RFP provided that Carriers interested in providing wireless service in the System would be solicited pursuant to a separate RFP process. Following a review of responses to the RFP, in late January, 2003, Maverick/Mikom was preliminarily designated as the successful vendor under the Vendor RFP and its current proposal contemplates that it will cost approximately $10,000,000 to install the System in the I-90 and I-93 tunnels.

On January 30, 2003, the Authority issued a Request for Proposals (the "Carrier RFP") to each of the Carriers. The Carrier RFP provided that each Carrier interested in operating within the System would pay to the Authority its share of System installation costs, base rent and additional use based rent. The Carrier RFP stated that the base rent was $7.92 per linear foot, the same rent being paid by the Carriers in other Authority tunnels, escalated annually by CPI. The Carrier RFP requested that each interested Carrier make a proposal for additional use-based rent. Following the Carriers' submissions of responses to the Carrier RFP in July 2003, the Authority met with each Carrier to discuss its proposal and to address any areas of concern to the Carriers respecting the System. From 2004 through 2006, the Authority had multiple meetings and discussions with each Carrier in order to negotiate agreements for Carrier participation in the CA/T Wireless Project. The Authority had reached agreements in principle with three of the Carriers at a negotiated rate and was in the process of negotiating definitive agreements with such Carriers when the Legislation was adopted.

The Authority's Proposal

Subject to the reservations set forth above, the Authority provides the following responses to the Vote and Order:

(1) A description of the useable space available for wireless attachments in the tunnels.

A description of the facilities and space available for wireless attachments is set forth at Exhibit A.

The Authority notes that the information presented at Exhibit A is based on projections prepared by the Central Artery Tunnel ("CA/T") Project prior to construction of the central artery tunnels. Upon information and belief, the facilities described in Exhibit A were installed by the CA/T Project in accordance with such projections; however, the Authority has not performed an inventory to determine the actual amount of useable space available for wireless attachments.

The Authority has not yet identified the potential witness who will support this response, but will provide such information shortly.

(2) The Authority's proposed rates and fees.

The Authority at this time is prepared only to provide a preliminary proposal for rates and fees to be charged Carriers for wireless attachments in the central artery tunnels. As previously noted, the approach mandated by the Legislation and the Vote and Order represents a significant departure from the analyses undertaken by the Authority over the past five years.

Presently, the Authority estimates that its costs associated with construction, operations, and maintenance of the System in the central artery tunnels total approximately **$15,008,968.95** (the "Total Cost"). The Authority expects that the Total Cost will be recouped upon the execution of agreements with participating Carriers. To the extent that it is recovered over time, the Authority expects that its cost recovery would include an annual rate which it presently estimates to be 10% of Total Cost, plus annual escalation based on CPI or similar measure. Such cost recovery rate includes the Authority's long term borrowing costs, administration and depreciation.

The Authority is still in the process of refining the foregoing estimates and reserves the right to supplement this component of the Proposal when it has completed its analysis of the foregoing factors.

The Authority has not yet identified the potential witness who will support this response, but will provide such information shortly.

(3) The method used to calculate the proposed rates and fees.

The Authority's proposal for rates and fees is based upon the expectation that it will recover its Total Cost. As noted in Section 2, above, to the extent that the Total Cost is recovered over time, the Authority expects that its cost recovery would include an annual rate which it presently estimates to be 10% of Total Cost, plus annual escalation based on CPI or similar measure. Such cost recovery rate includes the Authority's long term borrowing costs, administration and depreciation.

As to the Authority's Total Cost, the Authority has preliminarily identified the following cost components: (a) the replacement cost of installing conduit in the central artery tunnels in lieu of that proposed to be utilized by the Carriers;* (b) the cost of equipment space within the Central Office at Vent Building 6; (c) the cost of constructing the utility rooms appurtenant to the System in which rooms necessary System equipment will be located; (d) the Authority's to-date and projected expenditures on outside consultant fees in connection with planning, preconstruction coordination, and project management of the System; and (e) the Authority's projected expenditures on internal staff resources in connection with planning, preconstruction coordination, and project management of the System. There may be other costs in addition to those listed herein; the Authority reserves the right to supplement this component of the Proposal as additional information becomes available. The Authority's projected Total Cost does not include costs to be incurred by the Carriers and Selected Vendor in connection with planning, designing, installing and maintaining the System in the central artery tunnels, which costs are to be borne by such parties and not the Authority.

As noted above, the Authority's estimate of expected rate of return is based on its costs of borrowing capital to fund the construction of the System.

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* Subject to the review and approval of its Chief Engineer, the Authority is willing to consider an alternative proposal by the Carriers for the installation of new conduit as part of the overall construction of their system. Such installation would obviate the need for the Authority's recovery of replacement costs and therefore result in a reduction of the Total Cost estimated herein.

The Authority has not yet identified the potential witness who will support this response, but will provide such information shortly.

(4) Supporting data evidencing the anticipated construction, operation, and maintenance costs.

Attached hereto as Exhibit B is a preliminary summary of the costs attributable to each of the categories outlined in Section 3, above. Exhibit B-1 is a spreadsheet showing the estimated replacement cost for the conduit installed in the central artery tunnels. Exhibit B-2 presents estimates for the remaining cost items. The Authority notes that all figures presented in Exhibit B are preliminary and reserves the right to supplement them as necessary to accurately reflect the Authority's costs relating to the System.

The Authority has not yet identified the potential witness who will support this response, but will provide such information shortly.

(5) A detailed description of the proposed wireless communication system(s) to be installed.

A detailed description of the System is attached hereto as Exhibit C.

The Authority has not yet identified the potential witness who will support this response, but will provide such information shortly.

Respectfully submitted,

The Massachusetts Turnpike Authority,

By its attorney,

Johanna W. Schneider (BBO # 643744)
Choate, Hall & Stewart LLP
Two International Place
Boston, MA 02110
Tel.: (617) 248-5000

Exhibit A

Description of Useable Space

Phase II: Northbound Artery

Mainline and ramp tunnels. The I-93 Northbound Tunnel conveys traffic from points south, west and east to points north, as it crosses over the Charles River as the Leonard Zakim Bridge. The following section identifies each tunnel roadway and ramp associated with the Northbound Artery.

- **CANB Central Artery Northbound (Mainline)**
  Length: 8,000 +/- linear feet

- **Ramp DN**
  Length: 150 +/- linear feet

- **Ramp C**
  Length: 950 +/-linear feet

- **Ramp A-CN**
  Length: 630 +/-linear feet

- **Ramp R-T**
  Length: 1,300 +/- linear feet

- **Ramp A-CN / R-T**
  Length: 2,035 +/- linear feet

- **Ramp CN-SA**
  Length: 1,400 +/- linear feet

- **Ramp ST-S**
  Length: 925 +/-linear feet

- **Ramp ST-CN**
  Length: 1,000 +/-linear feet

- **Ramp ST-SA**
  Length: 600 +/-linear feet

- **Ramp CN-S**
  Length: 595 +/-linear feet

- **Ramp SA-CN**
  Length: 1,650 +/-linear feet

- **Ramp S-N**

Length: 630 +/-linear feet

Typical interior conditions. The Northbound Artery tunnels consist of four (4) 12'-0" wide travel lanes. The air intake or supply ducts are located beneath the travel lanes and the exhaust ducts are located within the tunnel ceiling. The nominal minimum roadway clearance for Northbound I-93 is 17'-0". For the ramp sections the nominal minimum roadway clearance is 14'-6". The exhaust depth sets the bottom of ceiling elevation. Interior features include precast concrete ceilings and direct applied tile walls.

Availability of conduit, power and telephone. Within the roadway and major ramps, there generally are two (2) spare 3-inch communications conduits; in minor ramps typically there is one (1) spare 3-inch communications conduit. In all cases, the Selected Vendor must install a plenum rated innerduct within the available conduit prior to installing their fiber optic or coaxial cable. The communication pull boxes are located within the median walkway along I-93 North and along the west side of the remaining northbound ramps. The IPCS, TV, TNL and emergency lighting pull boxes are located within the tunnel ceiling. Power is available within the utility rooms and ventilation buildings. Telephone service is available within the vent buildings.

Potential equipment room locations. Potential equipment room locations include tunnel utility rooms, ventilation buildings and vendor-supplied at-grade weatherproof enclosures. The Selected Vendor will be responsible for determining the availability of such space for all the above mentioned locations, on a case by case basis. Based on the Selected Vendor's space requirements and potential availability of space, all such requests must be submitted to the Authority for review and approval prior to installation.

Utility rooms contain equipment for monitoring and controlling vehicular traffic and are equipped with AC power. Along I-93 Northbound there are 17 subsurface utility rooms. All of the utility rooms are equipped with AC power. Fiber optic cable, connecting the main equipment to the remote equipment room, must be installed along the tunnel roadway within the spare communications conduit designated by the Authority. The Selected Vendor is responsible for verifying that spare conduit is available. If spare conduit is not available, the Selected Vendor must install surface-mounted FRE or RGS conduit to support this installation. The remote equipment would then be connected to the antenna system via the tunnel utility room.

<u>NOTE</u>: Some utility rooms located between I-93 Northbound and Southbound tunnel sections provide a physical connection or cross passage between northbound and southbound roadways. These shared utilities rooms should be utilized to the greatest extent possible, allowing the Selected Vendor to split the signal at the utility room and feed both northbound and southbound tunnels from the same room.

Ventilation buildings provide mechanical, electrical and control equipment necessary to furnish ventilation, power, lighting and control for the tunnels. Fresh air will be blown through ducts under the roadbed or in a tunnel wall and circulated through the tunnels by fans housed in the ventilation buildings. At the same time, vehicle exhaust will be carried out of the tunnel through openings in the ceiling to rooftop exhaust stacks in the ventilation buildings and dispersed high into the atmosphere. Ventilation buildings typically support both northbound and southbound roadway sections. Potential available space within the ventilation buildings is located throughout the building, within closets or in larger rooms which will be caged off. The final location of available space will be based on factors such as not precluding access to CA/T Project facilities and/or adhering to building code safety regulations. The Selected Vendor will be responsible for determining the availability of such space for all locations, on a case by case basis. Based on the Selected Vendor' s space requirements and potential availability of space, all such requests must be submitted to the Authority for review and approval prior to installation. In addition, a small dish or antenna array could be located on the roof of a vent building.

Ventilation Building #3, adjacent to I-93 Northbound along Atlantic Avenue, provides air intake and exhaust for both the northbound and southbound tunnels. This building consists of a basement and three floors above grade that contain electric and mechanical workshops, air supply ducts, an oil tank room, telephone security and radio equipment rooms, standby generator room, battery room, standby, switchgear rooms and a fire pump room.

At-grade weatherproof enclosures. Within the Authority right of way, there are areas where the vendor may wish to locate outdoor equipment enclosures. These enclosures would be at grade, requiring outdoor locked cabinets to support equipment installation. Power and telecommunications connections would also be required at these locations. The Selected Vendor would be responsible for installing the enclosure and ancillary equipment.

Phase III: Southbound Artery

Mainline and ramp tunnels. The I-93 Southbound Tunnel section extends from the I-90 Seaport Access Roadway interchange to Causeway Street in the vicinity of the Fleet Center. I-93 South continues over the Charles River as the Leonard Zakim Bridge. The following section identifies each tunnel ramp associated with the Southbound Artery.

- **CASB Central Artery Southbound (Mainline)**
  Length: 3,300 +/- linear feet

- **Ramp I-90 Collector**
  Length: 3,400 +/-linear feet

- **Ramp RR**
  Length: 350 +/-linear feet

- **Ramp CS-P**
  Length: 1,550 +/- linear feet

- **Ramp SA-CS**
  Length: 1,000 +/- linear feet

- **Ramp CS-CT**
  Length: 450 +/- linear feet

- **Ramp SA-CT**
  Length: 850 +/- linear feet

- **Ramp CS-SA**
  Length: 1,000 +/- linear feet

- **Ramp L-CS**
  Length: 1,230 +/- linear feet

- **Dewey Square Component**
  Length: 4,700+/- linear feet

Typical interior conditions. The I-93 Southbound Artery tunnels consist of four (4) 12 '-0" wide travel lanes. The air intake or supply ducts are located beneath the travel lanes and the exhaust ducts are located within the tunnel ceiling. The nominal minimum roadway clearance for the Southbound Artery is 17'-0". For the ramp sections the nominal minimum roadway clearance is 14'-6". The exhaust depth sets the bottom of ceiling elevation. Interior features include precast concrete ceilings and direct applied tile walls.

Availability of conduit, power and telephone. Within the roadway and major ramps, there generally are two (2) spare 3-inch communications conduits; in minor ramps there typically is one (1) spare 3-inch communications conduit. In all cases, the Selected Vendor must install a plenum rated innerduct within the available conduit prior to installing their fiber optic or coaxial cable. The communication pull boxes are located within the median walkway along I-93 Southbound and along the east side of the remaining Southbound ramps. The IPCS, TV, TNL and emergency lighting pull boxes are located within the tunnel ceiling. Power is available within the utility rooms and ventilation buildings. Telephone service is available within the vent buildings.

Potential equipment room locations. Potential equipment room locations include tunnel utility rooms, ventilation buildings and at-grade weatherproof enclosures to be supplied by the Selected Vendor. The Selected Vendor will be responsible for determining the availability of such space for all the above mentioned locations, on a case-by-case basis. Based on the Selected Vendor's space requirements and potential availability of space, all such requests must be submitted to the Authority for review and approval prior to installation.

Utility rooms contain equipment for monitoring and controlling vehicular traffic and are equipped with AC power. Along I-93 Southbound there are 11 subsurface utility rooms. Fiber optic cable, connecting the main equipment to the remote equipment room, must be installed along the tunnel roadway within the spare communications conduit designed by the Authority. The Selected Vendor is responsible for verifying that spare conduit is available. If spare conduit is not available, the Selected Vendor must install surface mounted FRE or RGS conduit to support this installation. The remote equipment would then be connected to the antenna system via the tunnel utility room.

<u>NOTE</u>: Some utility rooms located between I-93 Northbound and Southbound tunnel sections provide a physical connection or cross passage between northbound and southbound roadways. These shared utility rooms should be utilized to the greatest extent possible, allowing the Selected Vendor to split the signal at the utility room and feed both northbound and southbound tunnels from the same room.

Ventilation buildings provide mechanical, electrical and control equipment necessary to furnish ventilation, power, lighting and control for the tunnels. Fresh air will be blown through ducts under the roadbed or in a tunnel wall and circulated through the tunnels by fans housed in the ventilation buildings. At the same time, vehicle exhaust will be carried out of the tunnel through openings in the ceiling to rooftop exhaust stacks in the ventilation buildings and dispersed high into the atmosphere. Ventilation buildings typically support both northbound and southbound roadway sections. Potential available space within the ventilation buildings is located throughout the building, within closets or in dedicated areas of larger rooms which could be caged off. The final location of available space will be based on factors including, without limitation, not precluding access to CA/T Project facilities and/or adhering to building code safety regulations. The Selected Vendor will be responsible for determining the availability of such space for all locations, on a case-by-case basis. Based on the Selected Vendor's space requirements and potential availability of space, all such requests must be submitted to the Authority for review and approval prior to installation. In addition, a small dish or antenna array could be located on the roof of the vent building.

There are two above-grade ventilation structures adjacent to the Southbound Artery Roadway Tunnels, that provide fresh air supply and exhaust for both northbound and southbound tunnels. Ventilation Building #4 is located along Congress Street on the western side of the Central Artery, just north of Faneuil Hall. The building contains electric and mechanical workshops, air supply ducts, an oil tank room, telephone security and radio equipment rooms, standby generator room, battery room, standby, switchgear rooms and a fire pump room. Ventilation Building #8 is located between Causeway Street and Accolan Way, just south of the Charles River. The structure contains electrical and radio equipment rooms, fan rooms and a Boston Fire Department command room.

At-grade weatherproof enclosures. Within the Authority's right of way, there are areas where the Selected Vendor may wish to locate outdoor equipment enclosures. These enclosures would be at grade, requiring outdoor locked cabinets to support equipment installation. Power and telecommunications connections would also be required at these locations. The Selected Vendor will be responsible for installing the enclosure and ancillary equipment.

Exhibit B-1

Tunnel Raceway Replacement Cost Estimate

As provided in the attached Chart, the average replacement cost per linear foot of conduit in the central artery tunnels is $338.25. There tunnels comprise approximately 37,695 linear feet which results in a total cost of **$12,750,333**.

09/08/2006

Tunnel Raceway Replacement Cost Estimate

Tunnel Conduit Budgetary Cost Estimate

Typical 1,000 ft section

Labor Hours are assumed to be 3rd shift with a pay differential of 115%

Traffic closures and coordinated events create inefficiencies that result in 4 hrs of production in an 8 hr shift resulting in 50% production

Labor Pricing assumes a crew composed of 1 Foreman, 2 Journeyman and 1 Apprentice Electricians

Pricing is based on current quotes or where 2002 RSMeans was used, pricing was escalated at 3%/yr to 2006 = 113%

	Material Description	Unit Price Material	Unit Price Labor	Production Hours	Quantity	Ext. Mat Cost	Ext. Labor Cost	Item Subtotal	Item Hour Subtotal
Direct Costs:									
	Conduit 4" AISI Type 316	$39.67	$59.56	0.308	1000	$39,665.71	$18,343.63	$58,009.34	308
	Elbow 4", 45°	$120.91	$59.56	2.105	6	$725.46	$752.21	$1,477.67	12.63
	Elbow 4", 22½°	$60.46	$59.56	2.105	10	$604.55	$1,253.68	$1,858.23	21.05
	Pull Box 32x12x8, NEMA 4X Type 316	$4,972.00	$59.56	20	5	$24,860.00	$5,955.72	$30,815.72	100
	Water-tight 4" Grounding Hub	$264.08	$59.56	1.143	10	$2,640.81	$680.74	$3,321.55	11.43
	Support Channel 1-5/8, Type 316	$14.94	$59.56	0.133	300	$16,780.50	$2,376.33	$19,156.83	39.9
	Drilled-in Anchors ½"X2½"	$3.49	$59.56	0.107	400	$1,396.68	$2,549.05	$3,945.73	42.8
	SS Clamps, 2-hole with spgnuts/washer	$55.94	$59.56	0.16	200	$11,187.00	$1,905.83	$13,092.83	32
	Expansion/Deflection Fitting 4"	$796.65	$59.56	3.333	4	$3,186.60	$794.02	$3,980.62	13.332
	Equipment, Pickup/wk	$200.00			29	$5,811.42		$5,811.42	
	Equipment, Lift/wk	$320.00			29	$9,298.27		$9,298.27	
Directs Subtotal:						$116,157.00	$34,611.21	$150,768.21	581.1
Indirect Costs:									
	Temp Facilities Material =0.5% Labor				0.005			$173.06	
	Temp Facilities Labor =0.5% Labor				0.005			$173.06	
	Construction Utilities Material = 0.5% L				0.005			$173.06	
	Construction Utilities Labor = 0.5% L				0.005			$173.06	
	Cleanup Labor = 1.0% Labor				0.01			$346.11	
	Material Handleing Labor = 1.0% Labor				0.01			$346.11	
	Maintenance Labor = 1.0% Labor				0.01			$346.11	
	Survey Labor = 1.0% Labor				0.01			$346.11	
	Security Labor = 1.0% Labor				0.01			$346.11	
	Weather Protection = 1.0% Labor				0.01			$346.11	
	Small Tools and Consumables = 3.0% L				0.03			$1,038.34	
	Misc Construction Equipment = 3.0% L				0.03			$1,038.34	
	Field Supv and Eng. = 15.0% Labor				0.15			$5,191.68	
Subtotal Directs and Indirects:								$160,805.46	
Prime Contractor's O&P:									
	Overhead = 10.0% Directs and Indirects				0.1			$16,080.55	
	Profit = 10.0% Directs and Indirects				0.1			$16,080.55	
Traffic Set-ups and Police Details/day		$2,000.00			73			$145,285.50	
Total for typical 1,000 run in tunnel:								$338,252.05	
Price per foot installed:		$338.25							

Exhibit B-2

Additional Costs of System Construction

Space within Central Office at Vent Building 6:

Vent Building 6 has approximately 2,264 square feet which is available for occupancy by the Carriers and the Selected Vendor with System-related equipment. The per-square foot construction cost of Vent Building 6 is $225. Thus, if all 2,264 square feet are so occupied, then the total cost of Central Office space is **$509,400**.

Cost of constructing utility rooms appurtenant to the System:

The central artery tunnels contain a total of 28 utility rooms, of variable size, for Carrier use in connection with the System. It is assumed that the wireless equipment will be wall-mounted eighteen (18) inches deep and that, pursuant to National Electrical Code requirements, will require three (3) feet of clearance in front and a minimum width of thirty (30) inches. Accordingly, each utility room will require approximately 11.25 square feet of space for the wireless equipment. The per-square foot construction cost of the central artery tunnels is $4,121. The total utility space cost is 28 rooms x ($4,121/s.f. x 11.25 s.f/room), for a total construction cost of **$1,298,000**.

Outside consultants fees to date:

To date, the Authority has paid **$47,416.11** to outside consultants retained to assist in the planning of the System in the central artery tunnels.

Projected outside consultant fees:

Based on budget estimates provided by outside consultants retained by the Authority to assist with preconstruction coordination and project management in connection with System installation in the central artery tunnels and facilitation of participating Carrier connections to the System in the central artery tunnels, the Authority expects to pay additional fees of **$197,819.84.**

Projected Authority staff time:

The Authority anticipates that significant future Authority staff time will be dedicated to coordinating the installation and construction of the System in the central artery tunnels as well as on-going monitoring activities. The Authority conservatively estimates that such future activities will require approximately 2,060 person hours. At an average hourly rate of $100, the projected cost is **$206,000.**

Exhibit C

Description of System

SYSTEM DESIGN

Mikom's current portfolio includes low, medium and high power coverage systems using innovative and proven RF and fiber optic technologies capable of covering multiple bands simultaneously and satisfying any coverage or capacity enhancement challenges. Mikom's tunnel system installations include the Ted Williams, Callahan and Sumner Tunnels here in Boston. International tunnel installations have been completed in Berlin, Hanover and Munich, Germany as well as in Chile, Switzerland and France. In each installation Mikom prides itself on providing a system that meets or exceeds the project requirements and is delivered on time and within the established budget.

System Design and Compliance

Our team certifies that the proposed system, described herein, shall comply with the requirements of the Massachusetts Turnpike Authority's Request for Proposal, to that end, the proposed system is as follows.

The proposed system to be constructed utilizes the MIDAS MMR 800_1900 equipment, which will cover the requirements for present and planned technologies within the 800 and 1900 frequency bands used for mobile wireless communications. This includes CDMA, TDMA, LMR, DCS, IDEN, GSM, WCDMA and UTMS. The ranges of 806-894 MHz and 1850-1990 MHz define the working frequency spectrums for this system. Based on surveys and meetings conducted with the carriers, the proposed system provides ample capacity for current and future needs. Further, future expansion into new technologies and frequency bands, including the FCC's newly released 3G spectrum, is possible using the proposed fiber backbone and either installing a simple module or adding stand-alone equipment for frequencies not yet licensed or technologies not yet used. There are additional options included in this proposal for Public Safety, WLAN, and Paging as well.

The proposed system installation contemplates the construction of a multi-fiber, fiber optic backbone with fiber optic laterals to the proposed equipment locations within the tunnels. The fiber backbone provides redundancy and spare capacity anticipating the future needs of the carriers and developing technologies. At each equipment room, there are two remote MIDAS dual band fiber distributed antenna units. It is proposed that the carriers be divided among the two units – trunking and selected PCS on one half, cellular and other PCS on the other half. This arrangement creates a physical separation that eliminates the potential for intermodulation problems.

Another feature of the system design is in the location of the remote units. Coverage was designed at a minimum on-street mobile receive level of –80 dBm with overlapping coverage between remote units. Though Mikom's remote units are extremely reliable, this overlap has been built into the system design to ensure that minimal interruption (if any) will occur if a remote unit is not operational. This not only enhances the carrier coverage, capacity and reliability, it allows for ease in routine scheduled maintenance of the remote units. Design overlap also minimizes coverage disruption while replacing or upgrading the remote units – anticipating new technology integration at some point in the future.

Other system design features include:

- SNMP based operations and maintenance center (OMC) for monitoring and controlling the equipment.
- Auto leveling function to automatically level the downlink RF signal to ensure each carrier is operating at the designed level.
- Battery back up for a minimum of two hours at master and remote units.
- Sectorizing capability of the remote units.

Carrier Endorsement

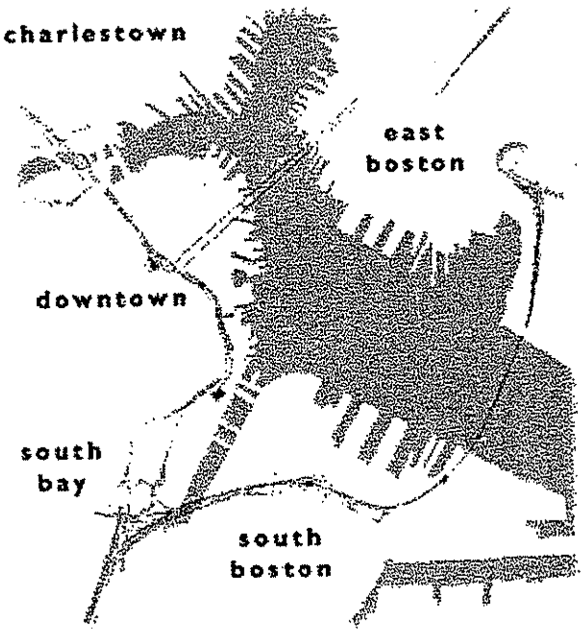
Maverick and Mikom have actively sought the input of carriers during the design of this neutral host wireless system. Central office layout, remote unit selection, antennas and redundancy design have all been reviewed with several carriers.

Our team boasts a client list that includes, AT&T Wireless, AT&T, Sprint PCS, Cingular, Verizon, Nextel, Voicestream, British Telecom , NSTAR Communications, NEESCom, RCN, XO Communications, Sprint, and the Town of Norwood.

An Allen Telecom Company

MIKOM

RADIO COVERAGE PROPOSAL FOR



Massachusetts Turnpike Authority Central Artery Tunnel Wireless Project
Boston, MA

HISTORY

Date	Spec Version	Author	Comments
08/12/02	1.0	Kim Stokes	Initial draft
09/04/02	1.1	Kim Stokes	Final Issue

Version: 1.0

	Name	Date	Signature
Checked by:	Greg Santee		
Approved by:	Greg Santee		

Table of Contents

MIDAS System

Overview

This document describes the fiber-based distributed antenna system required to meet the criteria in the Request for Proposals Central Artery Tunnel Wireless Project for multi-operator/multi-technology coverage within the Massachusetts Turnpike Authority Central Artery Tunnel, Boston, MA using Mikom's MIDAS solution.

The proposed MIDAS system will cover requirements for present and planned technologies within the 800 and 1900 frequency bands used for mobile wireless communications, including CDMA, TDMA, LMR, DCS, IDEN, GSM, WCDMA, and UMTS. The ranges 806-894 MHz and 1850-1990 MHz define the working frequency spectrums for this system. There is sufficient capacity in the system to meet the current and future needs of the carriers based on surveys conducted with several of them.

Future expansion into new technologies and frequency bands, including the newly FCC released 3G spectrum, is possible using the proposed fiber backbone and either the addition of a simple module to the equipment (as is the case for WLAN) or the addition of new stand-alone equipment for those new frequencies not yet licensed or technologies not yet developed.

~~This proposal also includes options for the Public Safety Systems operating in 800, 450 and 150 MHz frequency bands. The details are in the Public Safety section of this proposal.~~

The MIDAS system is very flexible and can be expanded to accommodate any future expansion into the Ted Williams Tunnel, Prudential, CANA Tunnels, and other areas. It was designed in a star configuration such that each remote unit has a direct connection back to the master unit without using any optical or RF splitters. This allows each carrier to sectorize the system individually for their use without affecting the other carriers, and it provides an easy means of interleaving the remotes for redundancy for Public Safety's use.

~~The MIDAS system utilizes an SNMP-based Operations and Maintenance Center (OMC) for~~ monitoring and controlling the equipment. Several users can access the system to varying security levels, and the OMC can be accessed via a LAN or WAN utilizing Ethernet, a PSTN phone line, or a wireless phone when used in conjunction with Ethernet routers and Ethernet modems. There is also a separate Local Maintenance Terminal at the headend for monitoring ~~and controlling the equipment locally~~.

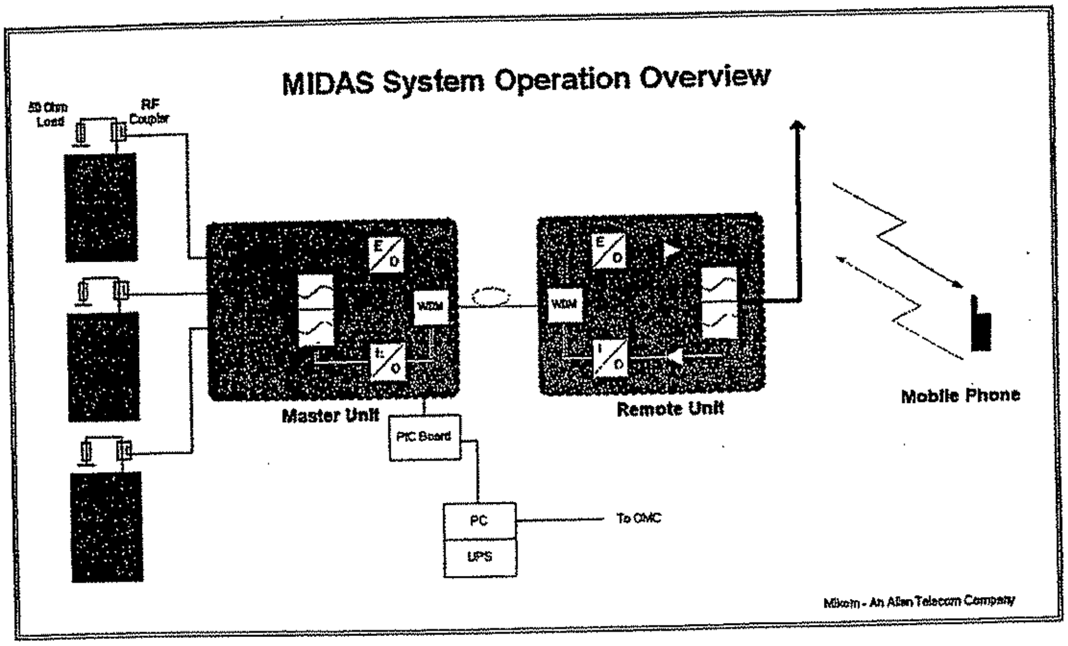
Coverage was designed in the public roadways at a minimum on-street mobile receive level of -80 dBm or better. This level will ensure there is sufficient in-vehicle coverage while also providing overlapping coverage between the remote units in case of equipment outages.

This proposal is based on using two side-by-side MIDAS dual-band fiber-based distributed antenna systems. The wireless carriers would be divided between the two dual-band systems with selected PCS and all Trunking carriers on one half of the system, and the other PCS carriers and all Cellular carriers on the other. The reason for the two systems is that the highest uplink frequency for the cellular band is too close to the lowest downlink frequency in the trunking band to effectively prevent feedback through the system. Separating the trunking and cellular operations eliminates the potential for intermodulation problems. Installing the antennas a specific distance apart vertically and/or horizontally further isolates the trunking and cellular systems.

MIDAS System Description

In the MIDAS network, RF couplers, terminations, and coaxial cable are used to connect the radio equipment to the MIDAS Master Unit at the head-end location. In the Central Artery/Tunnel Project, this location is the subbasement of Vent Building 6. There are variable attenuators in the Master Unit for each radio equipment connection so that each carrier can be optimally tuned to operate in the system. The radio equipment transmit (downlink) RF signal at the head-end is converted to an optical signal by the master unit. The optical signal is transported over single-mode fiber to a MIDAS Remote Unit where it is converted back to an RF signal, amplified, and then transmitted using standard coaxial cable and antennas.

In the radio equipment receive (uplink) path, the received signal from the mobile is amplified before being converted to an optical signal and transported back to the master unit location using the same optical fiber. At the master unit, the signal is converted back to a RF signal and carried via coaxial cable to the BTS. The following diagram illustrates this process.



MIDAS System for One Remote Unit (Single Frequency Band is Shown)

The MIDAS equipment utilizes optical wave division multiplexing (WDM) at 1310 and 1550 nm to combine the uplink and downlink signals to allow one fiber to be used instead of two, thus saving material costs. Additionally, the equipment has an auto-leveling function that automatically levels the downlink RF signals present at the Remote Unit to ensure that each operator is operating at the designed level. This eliminates the need to re-level the system as new channels are added to it, and it reduces the potential for interference between the carriers since one can't operate above the designed level. An automatic threshold alarm (ALC) will occur if the transmit or receive levels are too high. There is also a function to reduce the power transmitted and received at each Remote Unit using built-in attenuators, which can be used to optimize the network as a whole.

The MIDAS Master Unit and Remote Unit components shown in the previous drawing are replicated for each remote unit in operation as part of the star configuration. This configuration increases reliability, as each Master Unit-Remote Unit set is separate from the other Master Unit-Remote Unit sets. A failure on one component affects only that set, not the others. There is no single point of failure within the system.

The Master Unit communicates with each Remote Unit using a 10.7 MHz supervisory signal that is transmitted/received with the wireless frequencies over the single fiber. This allows the Remote Units to be accessed locally via the Local Maintenance Terminal (LMT) or remotely using the SNMP-based Operations and Maintenance Center (OMC) software. The remote connection to the OMC shall be accomplished using standard "always on" LAN connections.

~~Both the LMT and the OMC poll the Master and Remote Units for status, record current settings~~, and log alarms. Any alarms are forwarded to the remotely located maintenance staff for action. The LMT is also used to auto-setup the units after replacement to reduce mean time to repair (MTTR). Up to four external alarms can be connected to the Remote Unit using simple relay contacts to monitor other functions, such as the activation of a fire or flooding alarm. The following alarms are monitored in the MIDAS network:

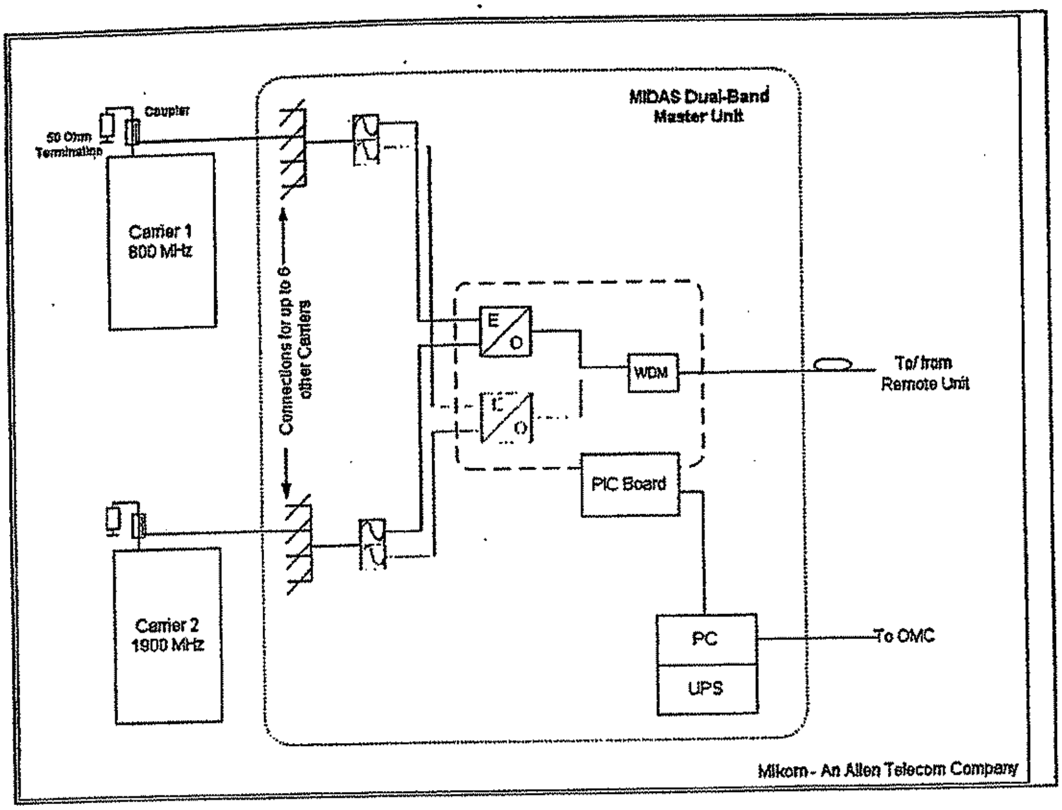
Alarm Message	Description
Optical RX alarm	Optical receive failure (no input)
Optical TX alarm	Optical tranmsit failure
Auto-leveling	Optical loss has changed
Amplifier current DL1	Amplifier current too high or too low
Amplifier current DL2	Amplifier current too high or too low
ALC alarm DL	Output power too high
ALC alarm UL	Input power too high
Temperature alarm	Temperature out of range
I2C bus failure	Internal communications bus failure
PSU 12 V	Power supply 12V failure
PSU 28 V	Power supply 28V failure
PSU mains	Power supply mains failure
Fan	Fan out of order
External alarm 1	Option for supervision of external components
External alarm 2	Option for supervision of external components
External alarm 3	Option for supervision of external components
External alarm 4	Option for supervision of external components

The MIDAS Remote Units can be mounted against a wall, attached to a pole, or located inside another enclosure, such as a lamppost. Each MIDAS Remote Unit has a fan housing with two fans on top to control the temperature inside the unit. The fans sense the temperature inside the unit and automatically adjust their speeds to cool the units as required. Power consumption is reduced since the fans only operate as needed. Under most operational conditions only one fan is required, only at extreme high temperatures are both fans required for operation. Under fan failure conditions, each amplifier contained in the Remote Unit has an auto-shutdown to prevent any damage to the Remote Unit.

MIDAS Dual-Band 800/1900 Operation

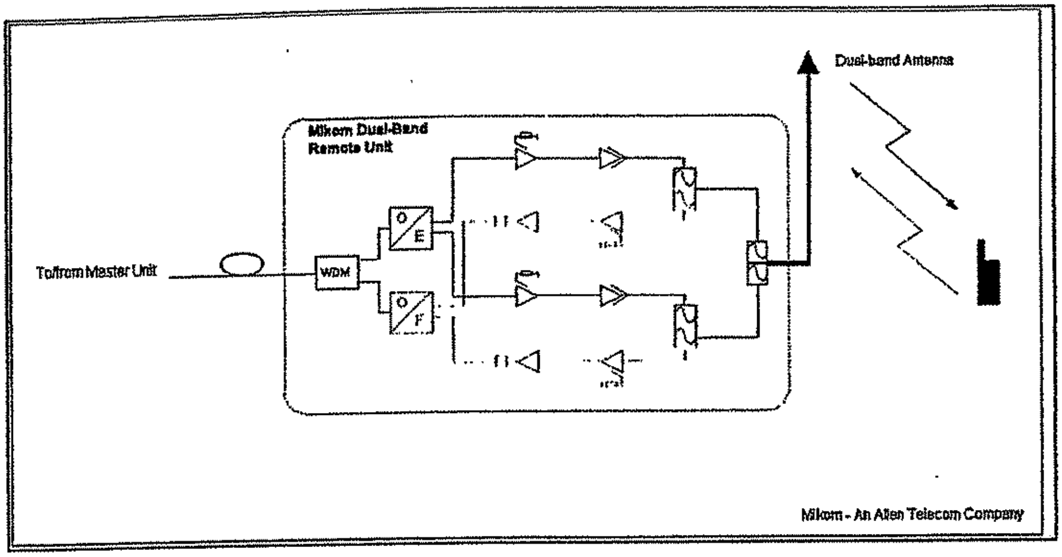
In a multi-operator environment, consideration must be given to the separation between the cellular and trunking bands. The highest uplink frequency for the cellular band is 2 MHz from the lowest downlink frequency in the trunking band, which can cause interference in any shared system. Separating the trunking and cellular equipment is therefore required, and this includes the antenna and coaxial cable used. Vertical separation between the trunking and cellular antennas is generally more effective than horizontal separation because of antenna radiation patterns, which put the maximum gain in the horizontal direction. 1900 MHz PCS systems can operate with either the cellular or trunking band to create a dual-band system.

The proposed MIDAS system for the Central Artery/Tunnel Project uses two dual-band 800/1900 systems to alleviate the cellular-trunking interference issue. Up to four wireless operators in each frequency band (for a total of 8 carriers) can use each system without the need for additional equipment in the Master Unit. As there are only 2 cellular and 6 PCS licenses, this provides sufficient room for the current commercial licensees. In the case of trunking and Public Safety, there are expected to be more than 4 radio cabinets to each Remote Unit, and the radio cabinets can be combined outside of the Master Unit using off-the-shelf RF splitters to provide the extra connection points. The diagram shown on the next page illustrates how the 800 MHz (cellular or trunking) frequency is combined with the 1900 MHz frequency at the MIDAS Master Unit.



MIDAS Dual-Band Master Unit

The MIDAS Remote Unit uses separate amplifiers for each frequency band to allow for the maximum power per channel possible. Each amplifier path also has a variable attenuator available to individually tune the Remote Unit and optimize the MIDAS network as a whole or in specific areas, such as near ramps. A duplexer recombines the frequencies to share the same dual-band antenna. The diagram that follows shows how this is accomplished.



MIDAS Dual-Band Remote Unit

The dual-band 800/1900 MIDAS equipment has all of the remote monitoring and control functions described previously. A specification sheet for the MIDAS equipment is included as Attachment A, and Attachment B is the specification sheet for the proposed 800/1900 multi-band bidirectional antenna proposed.

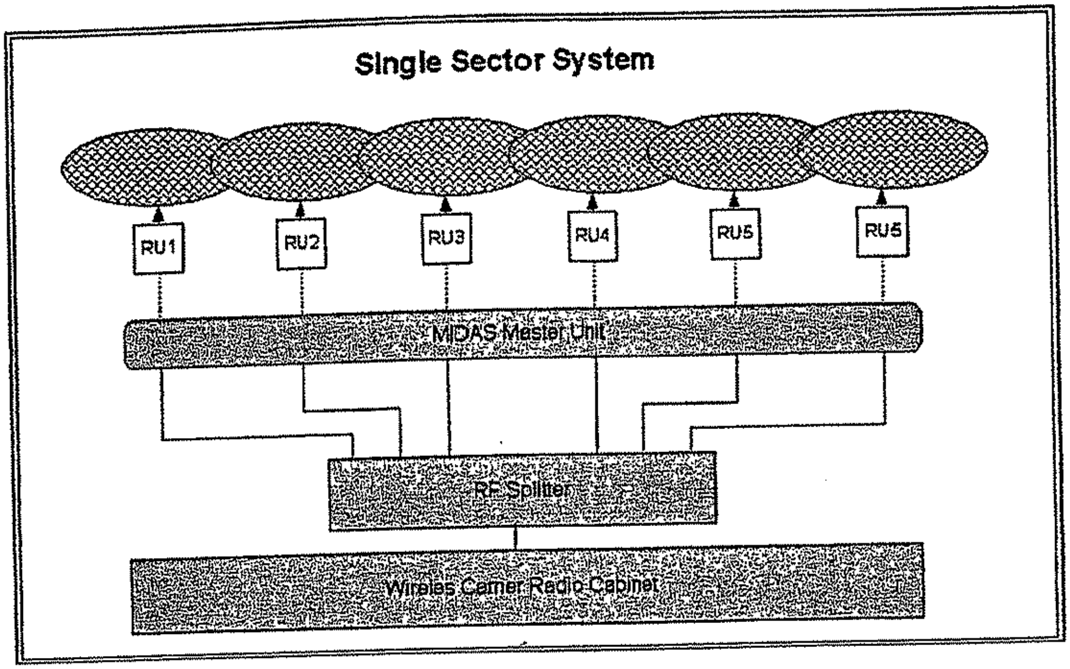
There are multi-operator MIDAS networks in Zurich, Switzerland; London, England; Cardiff, Wales; and Augsburg, Germany, currently using this technology. The system in London includes a third-generation UMTS operator, and there are plans for adding 3G operators on the Cardiff network. Previous generation dual-band MIDAS equipment is installed in San Francisco, CA; Las Vegas, NV; and Los Angeles, CA, and Mikom has other shared systems using its low-power BriteCell optical equipment in Atlanta, GA; New Orleans, LA; and a new system under construction in Dallas-Fort Worth, TX.

MIDAS Capacity

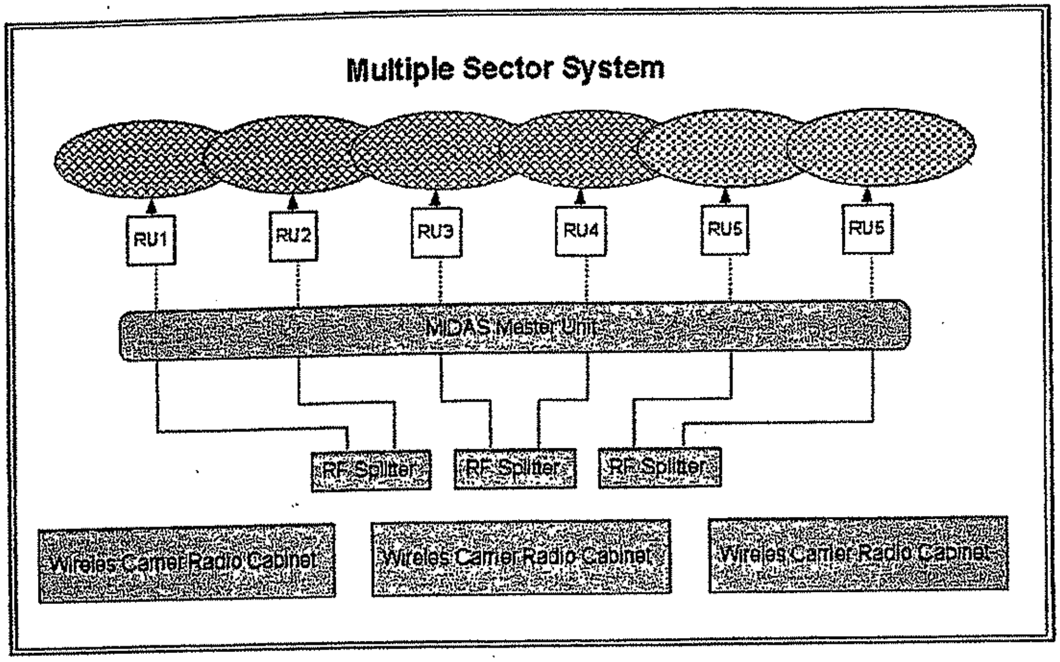
The proposed MIDAS system for the Central Artery/Tunnel Project has been designed with the following capacity at each Remote Unit.

- Trunking – 32 analog or iDEN channels
- Cellular – 32 channels (CDMA, TDMA, or combination of both)
- PCS – 32 CDMA carriers and 24 TDMA/GSM channels

Sectorizing the Remote Units can accommodate additional channels and system redundancy. For example, a carrier can begin service with a single sector of radio channels over a given number of Remote Units and then later allocate specific Remote Units to different radio groups as shown in the following two diagrams to increase overall capacity in the Tunnels. This is accomplished by changing the RF splitters at the headend location only. No access is needed at the Remote Units.

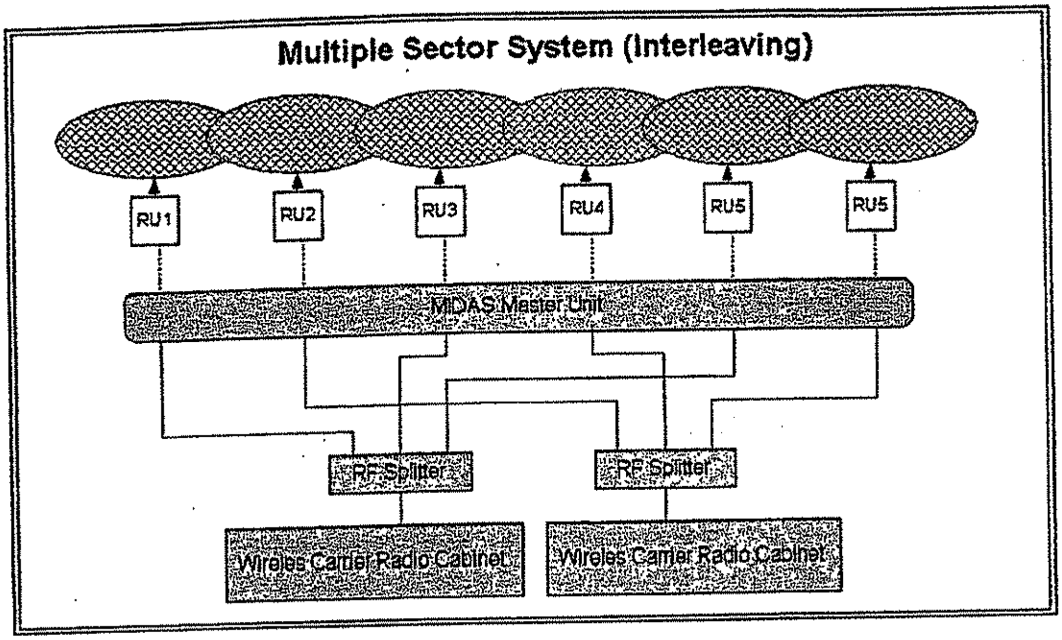


Single Sector MIDAS System



Multiple Sector MIDAS System

This type of flexibility has also been used to increase system reliability in case of radio equipment outages. Interleaving Remote Units fed by different radio cabinets is a common means of ensuring that service is available in the event of a radio equipment failure in the Public Safety sector that utilize distributed antenna systems. This is shown in the diagram that follows.



Interleaved Multiple Sector MIDAS System

Eventually, a wireless carrier could use one radio cabinet per Remote Unit for capacity if needed. For the purpose of providing consistent service to all of the wireless carriers on the system, the carriers will be limited to a maximum of 8 MIDAS Remote Units per sector. Adding more than 8 Remote Units will negatively affect the uplink call quality in comparison to the other carriers operating within that boundary. Reducing the number of Remote Units per radio cabinet can improve uplink quality for a carrier.

Proposed MIDAS Performance

The proposed MIDAS network has been designed for a minimum on-street mobile receive signal strength of –80 dBm or better. This level allows for effective in-vehicle coverage while minimizing the amount of equipment required. While the number of antennas and individual coaxial cable lengths may vary, a link budget for the system is included as Attachment C. The worst-case scenario for the Remote Unit configurations is shown although the number of antenna points per Remote Unit and the coaxial cable lengths may vary.

The Remote Unit locations and the link budget were created to provide overlapping coverage between the Remote Unit antenna points. This ensures that there is still RF coverage inside the Tunnel in the case of radio equipment failure.

~~Public Safety~~

The Public Safety channels listed in Appendix B: Existing and Planned CA/T Project Radio Frequencies are:

User	Uplink	Downlink
BPD-1	460.35	465.35
BPD-2	460.45	465.45
EMS Tactical	462.95	467.95
EMS Dispatch	462.975	467.975
EMS-4	463.075	468.075
EMS-5	463.1	468.1
EMS-8	463.175	468.175
BPD Area A	470.7875	473.7875
BAPERN	470.7875	473.7875
BFD-1	483.1625	486.1625
BFD-2	483.1875	486.1875
BFD-3	483.2125	486.2125
BFD-4	483.2375	486.2375
MBTA	483.5625	486.5625
Mobile Data-1	806.6375	851.6375
Mobile Data-2	808.5625	853.5625
MSP-1/MDC-10	811.7125	856.7125
MSP-2/MDC-9	811.7375	856.7375
MSP-3/MDC-8	812.9875	857.9875
MSP-4/MDC-7	814.7125	859.7125
MSP-5/MDC-6	814.9625	859.9625
MDC-5	814.9875	859.9875
MDC-4	815.7125	860.7125
MDC-3	815.7375	860.7375
MDC-2	815.9625	860.9625
MDC-1	815.9875	860.9875
Interagency Call-In	821.0125	866.0125
Interagency Tact 1	821.5125	866.5125

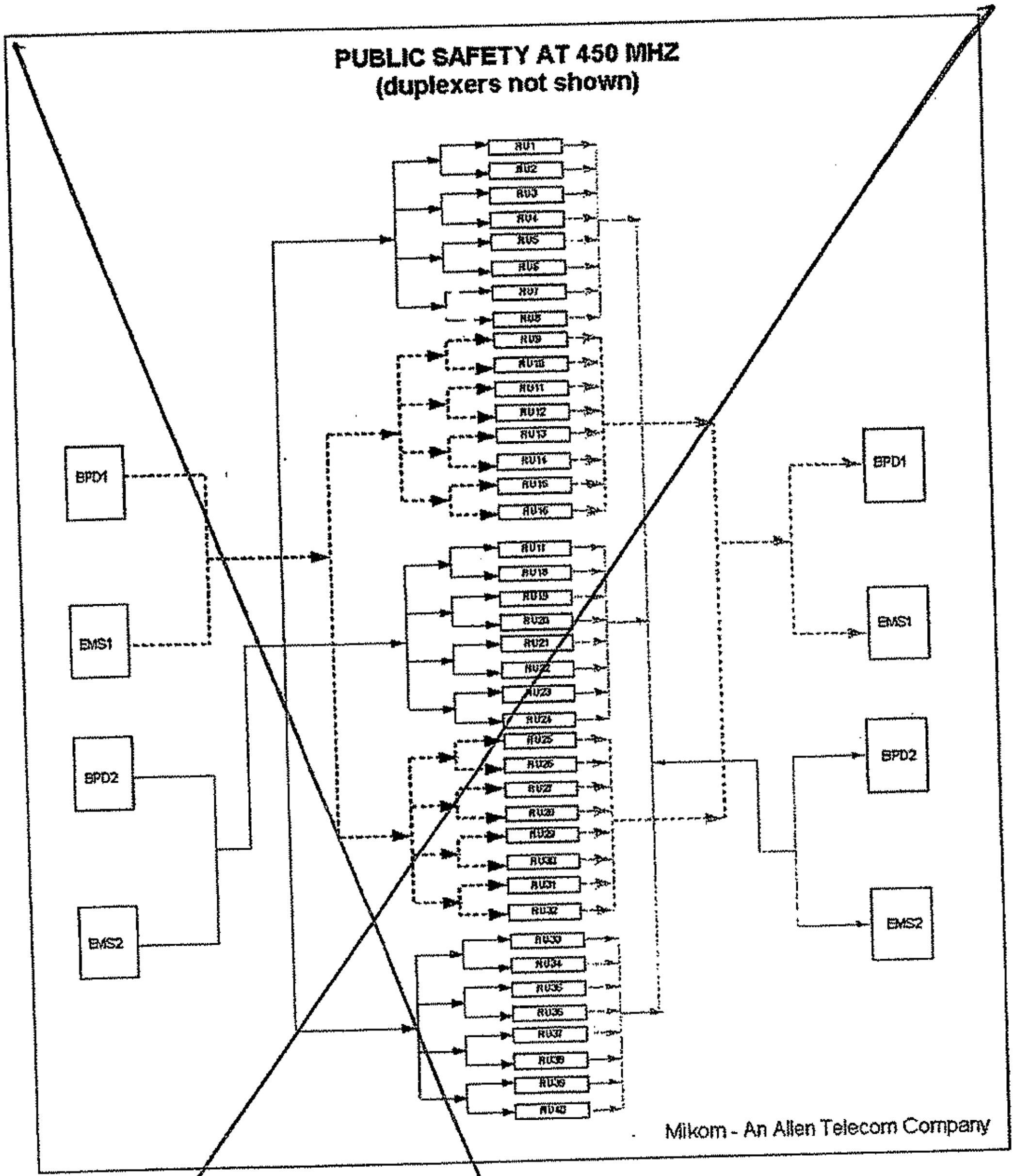
~~For the Public Safety services in the 800 MHz band, the Massachusetts State Police,~~ Metropolitan District Commission, the Interagency Call-In and Tact 1, and the Mobile Data Terminal can be added to the trunking side of the proposed MIDAS system with no additional equipment required for the Remote Unit or Master Unit. Only interconnection equipment between the radio cabinets and the Master Unit would be required, and the MIDAS Remote Units could be interleaved between the radio cabinets as previously described. For the frequencies shared by the Massachusetts State Police and Metropolitan District Commission, it is assumed that they also share radio cabinets in order to not intentionally interfere with each other. The average link budget for 800 MHz Public Safety is enclosed as Attachment F.

With respect to the Public Safety services in the 450 MHz frequency band, Mikom proposes to use its MOR200X product as an option for the proposed system. These optical repeaters are a proven product for TETRA/Public Safety in other parts of the world. Due to the large duplexers required, at least two units would be required at each equipment location, one to cover 460.35-463.175/465.35-468.175 and one for 483.1625-483.5625/486.1625-486.5625 services. The units would require 2 fibers to each, although they would share the same antenna.

For the Boston Police Department (BPD)/BAPERN services in the 470.7875/473.7875 channel, a third unit could be added although a second antenna would be required to isolate the downlink 468 MHz channels from the uplink of the 470 MHz channel. Given that BPD has other channels available in the 460.35-463.175/465.35-468.175 MHz range, this may be an unnecessary option.

Given the high expected mobile receive levels from mounting the equipment in the same MIDAS locations, a small omni-directional antenna is recommended as the additional antenna gain from directional antennas is not required. A copy of the data sheet for the MOR200X is attached as Appendix D, and a data sheet for a typical omnidirectional antenna is attached as Appendix E. The link budget for 450 MHz Public Safety is enclosed as Attachment F. Although 40 equipment locations are included in this proposal, the number used for 450 MHz Public Safety could be reduced with a lowered mobile unit receive signal strength intensity (RSSI) level while still providing redundant radio coverage. More information about the Public Safety systems is needed to determine exactly how many equipment locations would be required for the final system design.

The diagram on the next page illustrates how the 450 MHz system would incorporate redundancy in the system design by interleaving the radio cabinets between the remote units. Groups of eight remote units would be made to reduce the amount of equipment required while also achieving a balanced link budget. This set-up would ensure that radio coverage would still be available in the tunnels in the event of a radio cabinet failure. This configuration would apply to both 450 MHz systems as described in the previous paragraph although only one group is shown.



Similar to the 800/1900 MIDAS equipment the MOR200X Master Unit communicates with each Remote Unit using a 10.7 MHz supervisory signal that is transmitted/received with the wireless frequencies over the fiber cables. This allows the Remote Units to be accessed locally or remotely using the Operations and Maintenance Center (OMC) software. The remote connection to the OMC is accomplished with a PSTN phoneline, and the Master Unit is set up to poll the Remote Units on a pre-determined schedule.

Any alarms are forwarded to the remotely located maintenance staff for action. Up to four external alarms can be connected to the Remote Unit using simple relay contacts to monitor other functions, such as the activation of a fire or flooding alarm.

For the 150 MHz Public Safety services, Mikom proposes that the Massachusetts Turnpike Authority provide the radio cabinets and combining network for the various 150 MHz systems for each MIDAS equipment location (40 in all) under their existing contract agreements with the radio cabinet manufacturers. These radio cabinets would not utilize the fiber backbone, and they would connect to either the same antennas proposed for 450 MHz or similar ones. Although 40 equipment locations are included in this proposal, the number used for 150 MHz Public Safety could be reduced with a lowered mobile unit receive signal strength intensity (RSSI) level while still providing redundant radio coverage. More information about the Public Safety systems is needed to determine exactly how many equipment locations would be required for the final system design.

Alternatively, the 150 MHz services could be incorporated in the AM/FM Rebroadcast system although that design is not included in this proposal. Mikom does not manufacture equipment in the 150 MHz range so no OMC has been included in this option. However, the external alarms available on the 450 or 800/1900 MHz Remote Units could be used to provide a remote alarm in the case of a 150 MHz radio cabinet failure.

Proposed Installation Details

For the Central Artery/Tunnel Project, there are estimated to be 40 remote equipment locations and one master unit system located in Vent Building 6. The specification sheet for the MIDAS equipment is included as Attachment A. There will be 6 single-mode fibers at each equipment location, one for each MIDAS dual-band Remote Unit and 4 for future growth. If the Massachusetts Turnpike Authority desires to add 450 MHz services to the system, then 4 to 6 additional fibers would be required depending on how many units would be required at each location.

In Vent Building 6, there will be a secure equipment area housing the MIDAS Master Unit and the various RF combiner networks for each carrier. The wireless carriers will be linked to the MIDAS equipment area using ½" coaxial cable mounted in cable tray attached to the overheads. These cables will terminate in a bulkhead rack with RF connectors in an arrangement similar to what are used on shared tower systems. This is designated as the "Meet Me" point on the system drawings.

The other side of the bulkhead rack will be the secure equipment area where each carrier's radio cabinets (or sectors) will be split according to their desired configuration. The ancillary equipment to accomplish the configurations will be housed in an enclosure used exclusively for that carrier. Smaller RF cables will run from each carrier's enclosure to the appropriate Master Unit cabinets using overhead-mounted cable tray. All cables will be labeled to facilitate troubleshooting and future changes to the system. The Master Unit will have an uninterruptible power supply to provide for up to 2 hours service after power is lost.

Each MIDAS Remote Unit will be mounted against the wall in either the Utility Rooms or in the Cross Passages with 2 Remote Units in each location (1 PCS/Cellular, 1 PCS/Trunking). Uninterruptible power supplies will be provided at each equipment location to provide backup power to both remote units for up to 2 hours. Each Remote Unit will serve one to three bi-directional antennas mounted inside the tunnel using ½" coaxial cable, depending on the location. The RF splitters used to extend coverage from one Remote Unit to more than one Tunnel will be secured and waterproofed. The specification for the proposed antenna is included as Attachment B. There are a total of 40 equipment locations and 69 antenna locations, and these locations are included as Attachment G.

Access for the coaxial cable from the equipment room to the tunnels will be accomplished by core drilling through the Tunnel walls. Additional construction details are available on the preliminary system design drawings, and the final equipment locations and installation details will be submitted for approval prior to building the network.

Remote control and monitoring of the network will be done from the existing Maverick Construction Corporation Network Operations Center using the MIDAS OMC software.

Mikom and Maverick Construction Corporation will work together to turn-up and commission the network. Baseline signal levels will be recorded for all carriers, and a baseline drive test through the tunnels will also be performed. Mikom will be responsible for connecting each carrier to the network, including providing the initial interconnection equipment required. There will also be an annual inspection of the network to ensure it is operating properly.

Additional Information

Public Safety and Related Authority Uses.

The proposed 800/1900 MIDAS solution includes the Authority's and other agencies' public safety two-way radio systems in the 806-821/851-866 MHz trunking bands without any modification or additions to the proposed MIDAS equipment. The radio cabinets can be connected to the system in the same manner as the commercial wireless carriers and monitored remotely.

Mikom does manufacture and support technologies in the 450 MHz ranges and has provided an option in this proposal to provide equipment for that frequency band. Although 40 equipment locations are included in this proposal, the number used for 450 MHz Public Safety could be reduced with a lowered mobile unit receive signal strength intensity (RSSI) level while still providing redundant radio coverage. This option includes an OMC for remote control and monitoring the system.

Mikom does not manufacture equipment in the 150 MHz range but does support them and has provided an option in this proposal to provide radio coverage for that frequency band. Similar to the 450 MHz, the number of equipment locations could be reduced with a lowered mobile unit receive signal strength intensity (RSSI) level while still providing redundant radio coverage. No OMC has been included in this option although the external alarms available on the 450 or

~~800/1900 MHz Remote Units could be used to provide a remote alarm in the case of a 150 MHz radio cabinet failure.~~

System Interference

The proposed MIDAS solution will not interfere with any CA/T Project equipment or the operation of the CA/T Project systems.

Mutual RF Interference Study

Based on our experiences around the world, Mikom does not anticipate any interference problems between the Public Safety two-way radio systems, the AM/FM Rebroadcast Radio systems, and the proposed 800/1900 MIDAS network for several reasons:

1. The licensed frequency bands are allocated to reduce potential for interference in uncontrolled environments. As long as the AM/FM Rebroadcast radio systems operate within their designed transmit power levels and the two-way radio systems operate with some separation between channels, there should be no interference between the systems.
2. The MIDAS solution is based on a star-configuration where each Remote Unit has an individual link back to the Master Unit. If the network were a cascaded bi-directional amplifier system where each remote was directly connected to another remote, then there might exist the potential for intermodulation products to build up through the cascaded chain of amplifiers. With a star configuration, this is not possible.
3. The auto-leveling function of the 800/1900 MIDAS equipment keeps the power levels of each of the carriers on the system at the same levels to prevent intermodulation products from forming. The automatic threshold controller (ALC) will also send an alarm when the transmit or receive power level is too high at the Remote Unit.

If Mikom is the Selected Vendor, then Mikom will contract with Comsearch to conduct a Mutual RF Interference study as required in Section II-A of the RFP. Comsearch is a division of Allen Telecom and is well recognized throughout the wireless industry for their expertise in performing intermodulation and interference analyses. Comsearch uses ComSite Plus, a computer program by Douglas Integrated Software. The potential interference mechanisms that are examined are: Transmitter Intermodulation, Receiver Intermodulation, Transmitter Noise, Receiver Desensitization, Harmonic Interference, and Spurious Interference. Mikom will work with the carriers and Comsearch to resolve any predicted interference or desensitization problems and present the final solution to the Authority. The full study is estimated to require 30 days to complete.

Evaluation Plan

Mikom will add each wireless carrier to the MIDAS system to ensure that the desired configuration is achieved, the optimal RF levels are set, and to verify the proper operation of the system. Although unlikely, if interference is present, Mikom will take the necessary steps to eliminate it, including bringing in additional expertise from other Mikom offices around the world. Mikom's portfolio of tunnel systems includes the Ted Williams, Sumner, and Callahan Tunnels in the Boston area alone. Mikom also has tunnel systems around the world with systems in Berlin, Munich, and Hanover, Germany; Santiago, Chile; Vereina, Switzerland; Monaco, France; San Francisco Municipal Transportation Authority, and the Washington Metro Transit Authority; to name just a few. We are very familiar with the unique environment inside tunnel systems and have the expertise to resolve any issues that arise.

Accommodation of Future Expansion

The proposed MIDAS system allows for expansion on many levels:

1. Capacity- The system was designed for the current needs of the wireless carriers and their anticipated growth so those additional channels can be added without having to re-level the entire network. We have also included extra fibers throughout the system for additional MIDAS equipment if it is needed beyond the anticipated demand or for new services, and we have included the costs for that equipment in the Projected Operation Costs.
2. Technology- The system is capable of handling all current technologies in the licensed frequency bands and 3G technologies, such as W-CDMA/UMTS and CDMA2000. A 3G UMTS operator is already using the MIDAS network on Oxford Street in London, England.
3. New Technologies- Extra fiber is located in every equipment location to accommodate new technologies that can't be included in the proposed MIDAS equipment and would be installed as stand-alone systems. Mikom's research and development team is constantly developing new ways to incorporate new technologies into our portfolio of products. We have also included an estimated cost for adding new technologies in the Projected Operation Costs.
4. Physical Space- The secure equipment area in Vent Building 6 includes extra room for adding additional Master Unit cabinets or other headend equipment for new services. The MIDAS Remote Units have a relatively small enclosure for the power available and will be mounted against the walls inside the Utility Rooms to facilitate room for additional remote equipment.

HVAC System

The MIDAS Remote Units have an IP67/NEMA 4 enclosure with built-in fans to control the temperature. The fans automatically adjust their speeds to regulate the temperature and minimize power consumption. The MIDAS Master Unit is a secure equipment cabinet that only requires the outside temperature to be less than 40 C/104 F. Similar to most outdoor radio equipment cabinets, the Master Unit does not require additional ventilation as long as the outside temperature can be maintained, and initial calculations indicate that additional ventilation is not required in Vent Building 6 for the MIDAS system. Formal calculations for the rejected heat of the equipment will be provided in the design drawings submitted for final approval.

Energy Efficiency

The MIDAS equipment is energy efficient when compared to similar products available in the market. The Remote Units use 350 W per unit and the Master Unit 15 W per Remote Unit plus the power for a local PC. For the proposed system, the power consumption is less than 1500 W in Vent Building 6 and 700 W at each Remote Unit equipment location.

Monitoring and Control Capabilities

The proposed MIDAS system will utilize Mikom's OMC software and Maverick's existing Network Operations Center. The OMC software and the Local Maintenance Terminal allow technicians to set all system settings and retrieve alarms either remotely or locally. There are no field-replaceable parts in the Remote Unit. In the case of failure, the units will be swapped out in whole and sent to the Mikom factory for diagnosis and repair. There are field-replaceable units in the Master Unit, which can be repaired on site. Spare parts will be stocked for both units to minimize troubleshooting and MTTR. The estimated MTBF on the equipment is approximately 10 years so there are generally few failures over the lifespan of the equipment.

Technicians are available 24x7 every day of the year to respond to alarms, and Mikom staff will be available to assist with recurring and more complex issues.

System Redundancy

Redundancy has been designed into the system on several levels.

1. Each Master Unit-Remote Unit connection is unique so that a failure in one part of the system does not affect the other parts.
2. The system has been designed to provide continuous coverage and overlap between the antenna points. In the case of an equipment failure on one part of the system, coverage is degraded to a still-usable level while repairs are carried out.
3. The Master Unit and Remote Units are supported by up to 2 hours backup power in case of an electrical outage.
4. The Remote Units can be connected via the Master Unit to the radio cabinet in any configuration desired by the carrier. In the case of 800 and 450 MHz Public Safety, these connections can be made to provide coverage inside the Tunnels in the case of a radio cabinet failure through the use of interleaving.
5. Under normal conditions, only one fan inside the Remote Unit is required for cooling, and the second fan can be considered redundant except under extreme heat conditions.
6. There are 4 external alarms on the Remote Unit that can be used to provide redundancy for other Central Artery/Tunnel systems, such as the activation of fire or flooding alarms in the areas where there are Remote Units located.

It is also possible to make the system fully redundant by constructing a second Master Unit equipment location, installing separate electrical feeds for all equipment locations, running the fiber runs along different paths, and duplicating the remote equipment. This is included as a separate option in the System Costs and Operation Costs forms. The wireless carriers on the system would also have to duplicate their radio cabinet equipment for the system for full redundancy.

Attachment A – MIDAS MMR800/1900 Equipment Specification Sheet

PRELIMINARY

MIKOM
AN ALLEN TELECOM COMPANY

MIKOM MULTI OPERATOR REMOTE Dualband Optical System — MMR 800/1900

The MMR800/1900 is connected to a central master unit through optical fiber lines. Specific custom designs for lamp poles, wall mount, below ground are available.

Remote control and Alarm handling

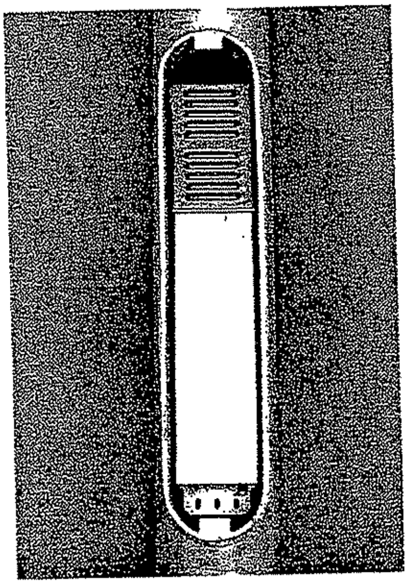
Mikom's MMR800/1900 multi operator remote unit has a simple alarm and control mechanism that may be interfaced locally at the master unit (co-located with the BTS) or remotely at an OMC.

The master unit has three functions. It produces contact relays that may be directly connected to the ancillary alarms on BTS, it communicates to an OMC and it has a local maintenance interface.

The MMR800/1900 is an intelligent system. Setup is simplified and functional operation is guaranteed through the use of a measurement receiver attached to the output port of the remote unit. This receiver provides output power and quality measurements to set up and monitor the system for optimal operation as defined below.

MMR800/1900 is virtually maintenance free.

- **Small form factor and high power**
- **Easy to install due to light weight and small dimensions**
- **Invisible mounting possible (for example inside lamp poles)**
- **Efficiency with all commonly used communication standards**
- **Single and multi-operator use**
- **Low power consumption**



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PRELIMINARY

MIKOM
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MIKOM MULTI OPERATOR REMOTE Dualband Optical System

MMR 800/1900

ELECTRICAL SPECIFICATIONS — MMR800/1900

AC power	
Mains power	110 V AC; 240 V AC or 24 V DC
Power consumption	360 W

INTERFACE SPECIFICATIONS — MMR800/1900

BTS interfaces	
Number of connectors per band	up to 4 duplexed ports
Input power	33 dBm typ. (up to 46 dBm with UL performance degradation)
Antenna port	
Connector	N female
Output power	see band specification
Optical link	
Connectors	SC/APC 8°
Tx output power (opt.)	0 to 7 dBm opt.
Tx input power (el.)	0 dBm max. composite
Rx input power (opt.)	+7 dBm max.
Opt. link budget	0 to 10 dB opt.
Opt. return loss	45 dB min.
Fiber type	Single-mode 9/125um

SYSTEM SUPERVISION — MMR800/1900

Control commands	RF off external control ports
Control output data	pilot power composite output power
Alarm outputs	summary alarms PSU failure over power failure over temperatures failure external alarm contacts

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PRELIMINARY

MIKOM
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MIKOM MULTI OPERATOR REMOTE Dualband Optical System

MMR 800/1900

800 MHz section	MMR800/1900			
Downlink				
Frequency range	869-894 MHz (AMPS) or 851-869 MHz (Trunking)			
RF output power (dBm/carrier)	Analog	TDMA	CDMA	IDEN
4 Carriers	26	31	28	26
8 Carriers	23	28	25	23
16 Carriers	20	25	22	20
32 Carriers	17	22	19	17
Intermodulation	< - 13 dBm and –45 dBc spec.regrowth for CDMA			
System gain	depending on BTS power			
Uplink				
Frequency range	824-849 MHz (AMPS) or 806-824 MHz (Trunking)			
Sensitivity	-145 dBm/Hz (up to 4 Remote units per sector)			
Input ICP3	- 20 dBm			
System gain	depending on BTS DL power			

1900 MHz section	MMR800/1900		
Downlink			
Frequency range	1930-1990 MHz		
RF output power (dBm/carrier)	GSM	TDMA	CDMA
4 Carriers	30	31	28
8 Carriers	27	28	25
16 Carriers	24	25	22
32 Carriers	21	22	19
Intermodulation distance	< - 13 dBm and –45 dBc spec.regrowth for CDMA		
System gain	depending on BTS power		
Uplink			
Frequency range	1850-1910 MHz		
Sensitivity	- 150 dBm/Hz (up to 4 Remote units per sector)		
Input ICP3	- 20 dBm		
System gain	depending on BTS DL power		

PRELIMINARY

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MIKOM MULTI OPERATOR REMOTE Dualband Optical System

MMR 800/1900

Environmental and safety	MMR800/1900
Environmental and safety	according to ETS 300019 (European Telecommunication Standard); see also 'Environmental and Safety' leaflet for MIKOM indoor cell enhancers. Operating temperature: Normal temperature range: + 5° C to + 40°C;
Low temperature limit	-33 °C
High temperature limit	+50 °C
Ingress protection	IP67

All data is subject to change without notice!

PRELIMINARY

MIKOM
AN ALLEN TELECOM COMPANY

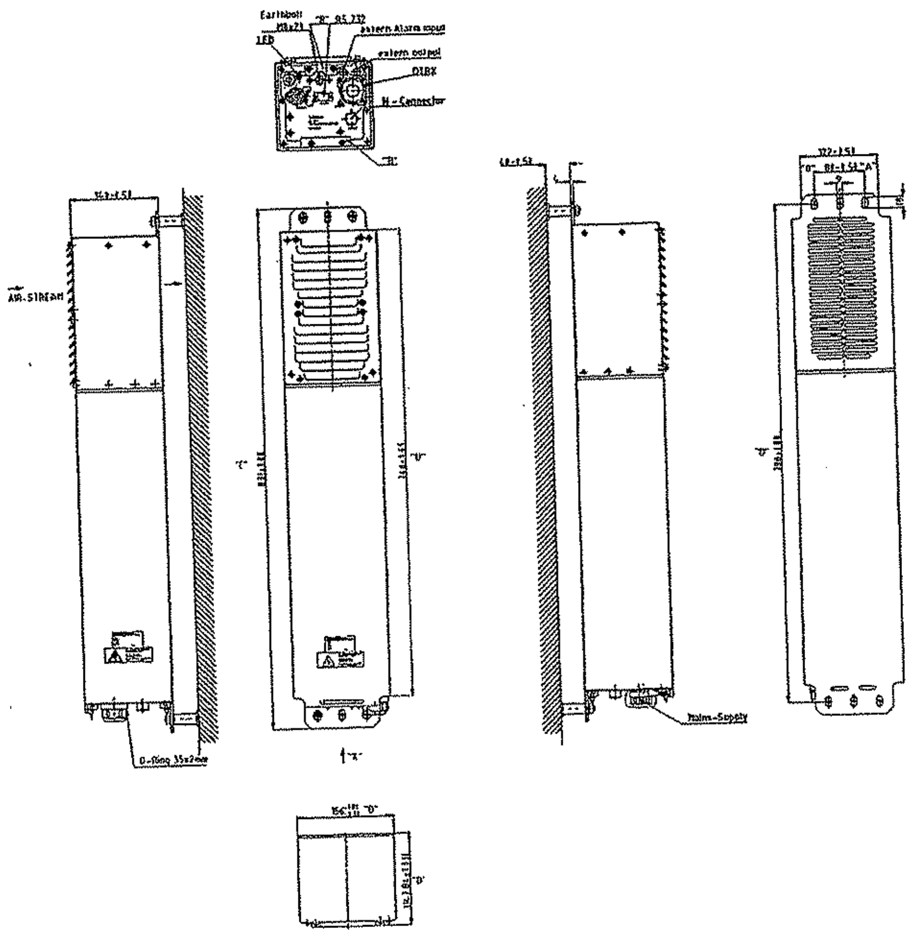
MIKOM MULTI OPERATOR REMOTE — MMR 800/1900
Dualband Optical System

MECHANICAL SPECIFICATIONS*

MMR800/1900

Property	Dimension	Additional Information
Height	32.7" (83.1 cm)	Outdoor / indoor mounting
Width	6.1" (15.6 cm)	Spacing required: 2.0" (50 mm) around unit, do not block air outlet
Depth	5.8" (14.8 cm)	
Weight	~9.1 lbs (20 kg)	

*With mounting brackets



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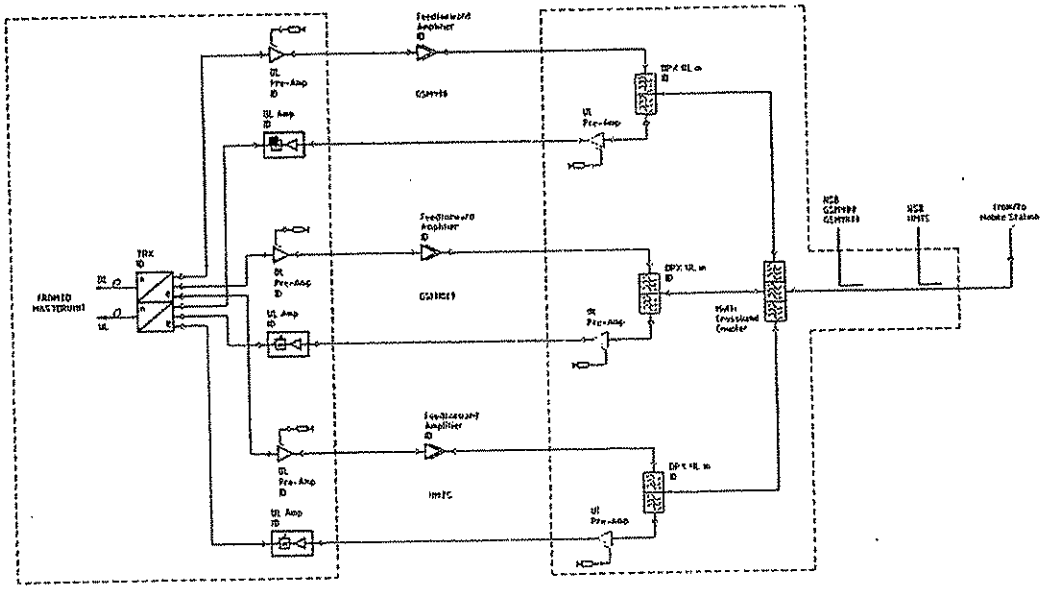
PRELIMINARY

MIKOM MULTI OPERATOR REMOTE Dualband Optical System

MMR 800/1900

DESIGN PRINCIPLE

MMR800/1900



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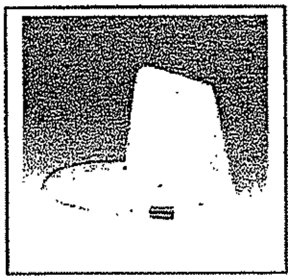
Attachment B – Proposed 800/1900 Antenna Specification Sheet

MAT JAYBEAM

Type 5029
Wide Band Microcell Antenna
Indoor & Outdoor
2G , 3G and TETRA

Jaybeam



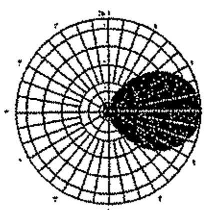
Type Number: **5029 000**

A useful directional Microcell 'Sharks Fin' antenna that gives very good performance over all currently used bands, including 3G UMTS and 800MHz TETRA systems.

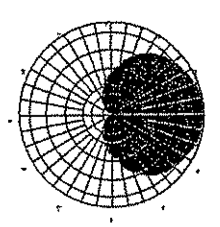
Electrical Characteristics	5029 000
Frequency	800 – 2200 MHz
Gain (max)	5 ± 1 dBi
Power	50 W
VSWR	2:1 maximum, 1.5:1 over of 95% of the band
Polarisation	Vertical
Horizontal Beamwidth	Typically 115°, -3 dB points 205°, -10 dB points
Front to Back Ratio	16 dB below beam maximum
Elevation Beamwidth	Typically 70° -3 dB points 125° - 10 dB points
Lightning Protection	Direct ground all conductive components
Impedance	50Ω
Terminations	500 mm RG303 cable White jacket terminated in 'N' socket

All antennas are DC Grounded

Typical Radiation Pattern (E Plane)



Typical Radiation Pattern (H Plane)



Mechanical Characteristics	
Material	ABS Colour White
Dimensions	282 x 85 x 182 mm
Weight	0.5 kg
Wind Loading	70 N maximum @ 160 km/hour

General Antenna Information

Mounting Accessories:
Screws supplied for mounting on flat wall. Optional brackets for pole mounting 48 to 115 mm using bracket and metallic clips.

ASCII format radiation patterns are available upon request.

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Rutherford Drive, Park Farm South, Wellingborough,
Northamptonshire, NN8 6AX, England
Tel: +44 (0) 1933 408408 Fax: +44 (0) 1933 408404
WWW.jaybeam.co.uk

MAT Equipement
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WWW.matequipement.com

Attachment C – Average Link Budget for 800/1900 MIDAS Central Artery/Tunnel Wireless Project

Parameter	800 Trunking (32 channels)	850 TDMA (32 channels)	1945 TDMA/GSM (24 channels)	850 CDMA (32 channels)	1945 CDMA (32 channels)
UPLINK					
Mobile Unit TX (dBm)	30.00	30.00	30.00	23.00	23.00
Mobile Unit TX (Watts)	1.00	1.00	1.00	0.20	0.20
Mobile Antenna Gain (dBi)	0.00	0.00	0.00	0.00	0.00
Mobile EIRP (dBm)	30.00	30.00	30.00	23.00	23.00
Mobile EIRP (Watts)	1.00	1.00	1.00	0.20	0.20
Noise Power Spectral Density					
kT (dBm/Hz)	-174.00	-174.00	-174.00	-174.00	-174.00
Interference Margin (dB)	3.00	3.00	3.00	3.00	3.00
Total Remote Unit Noise Figure (dB for 8 remotes)	15.00	15.00	15.00	15.00	15.00
Interference plus noise power spectral density (dBm)	-156.00	-156.00	-156.00	-156.00	-156.00
SNR 9 dB or Eb/No 7 dB	9.00	9.00	9.00	7.00	7.00
Spectral Bandwidth (kHz)	44.77	44.77	53.01	60.97	60.97
Processing Gain	0.00	0.00	0.00	-8.00	-8.00
Minimum Signal Level at Remote Unit (dBm)	-102.23	-102.23	-93.99	-96.03	-96.03
Maximum Allowable Uplink Path Loss	132.23	132.23	123.99	119.03	119.03
DOWNLINK	—	—	—		
Remote Unit TX (dBm) *PPS Only for CDMA	17.00	22.00	22.00	19.00	19.00
Remote Unit TX (Watts)	0.05	0.16	0.16	0.08	0.08
Splitter Loss	-4.70	-4.70	-4.70	-4.70	-4.70
Remote Unit Average Coax Length (ft)	120.00	120.00	120.00	120.00	120.00
Remote Unit Average Coax Loss	-3.86	-3.86	-4.82	-3.86	-4.82
Remote Unit Antenna Gain (dBi)	5.00	6.00	6.50	5.00	6.50
Remote Unit EIRP (dBm)	13.44	18.44	18.98	15.44	15.98
Remote Unit EIRP (Watts)	0.02	0.07	0.08	0.03	0.04
Noise Power Spectral Density					
kT (dBm/Hz)	-174.00	-174.00	-174.00	-174.00	-174.00
Interference Margin (dB)	3.00	3.00	3.00	3.00	3.00
Handset Noise Figure (dB)	8.00	8.00	8.00	8.00	8.00
Interference plus noise power spectral density (dBm)	-163.00	-163.00	-163.00	-163.00	-163.00
SNR 9 dB or Eb/No 7 dB	9.00	9.00	9.00	7.00	7.00
Spectral Bandwidth (kHz)	44.77	44.77	53.01	60.97	60.97
Minimum Signal Level at Handset (dBm)	-109.23	-109.23	-100.98	-95.03	-95.03
Maximum Allowable Downlink Pathloss (dBm)	126.23	131.23	122.99	114.03	114.03
Maximum Allowable Uplink Pathloss (dBm)	132.23	132.23	123.99	119.03	119.03
Additional Losses					
Body Loss (dB)	-1.00	-1.00	-1.00	-1.00	-1.00
Vehicle Penetration Losses (dB)	-8.00	-8.00	-8.00	-8.00	-8.00
Fast Fade Margin (dB)	-4.00	-4.00	-4.00	-4.00	-4.00
Slow Fade Margin (dB)	-5.00	-5.00	-5.00	-5.00	-5.00
Distance from Remote Unit (m)	800.00	800.00	800.00	800.00	800.00
Free Space Path Loss from Remote Unit (dB)	78.27	78.80	85.99	78.80	85.99
Total Path Loss for Distance from Remote Unit w/Losses	96.27	96.80	103.99	96.80	103.99
In-Vehicle Expected Mobile Unit RSSI (dBm)	-83.00	-78.00	-85.00	-81.00	-88.00
On-street Expected Mobile Unit RSSI (dBm)	-75.00	-70.00	-77.00	-73.00	-80.00

* Assumes PPS 20% Total Power Available

~~Attachment D – MOR200X Specification Sheet for 450 MHz Public Safety~~

MIKOM
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OPTICAL REMOTE UNIT WIDE BAND IN UL AND DL 400 MHz Applications

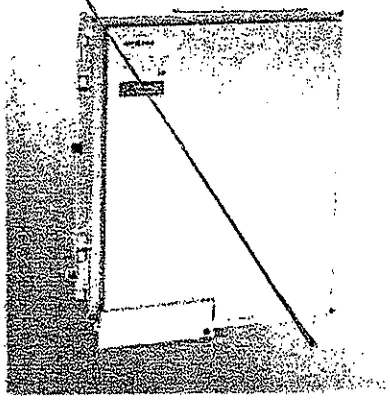
MOR200X

The optical Remote Unit MOR200X is a wide band repeater, which bi-directionally amplifies signals between mobile stations and a base station in a 400 MHz network using optical fibres for interconnection to a Master Unit(*). This enables radio coverage in regions where satisfactory quality of communication is not available.

The Remote Units can be controlled remotely via the corresponding Master Units by using the optical fibres. This can be achieved by means of several devices (VT100 terminal / modem / cross connect) connected to the Master Unit. The design of the repeater comprises a large number of functions, which the operator may monitor via terminal emulation program or the MIKOM OMC software platform. An easy to understand and fast to learn communication language supports the operator to query status reports from the repeater or to change settings.

(*) Special sets of datasheet are available for Master Unit configuration.

- **Remote control via Master Unit**
- **Small size and weight**
  Less than 51 litres
- **Built in test equipment**
- **Easy and fast to install and to upgrade**



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MIKOM
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OPTICAL REMOTE UNIT WIDE BAND IN UL AND DL 400 MHz Applications

MOR200X

ELECTRICAL SPECIFICATIONS	MOR200X
Frequency range UL:	380 to 385 MHz or 385 to 390 MHz or 410 to 415 MHz or 415 to 420 MHz or 450 to 455 MHz or 455 to 460 MHz 463.925 MHz to 464.775 MHz
Frequency range DL:	390 to 395 MHz or 395 to 400 MHz or 420 to 425 MHz or 425 to 430 MHz or 460 to 465 MHz or 465 to 470 MHz 479.050 MHz to 479.900 MHz
Gain	UL: 50 dB typ.; DL: 60 dB typ.
Gain setting range	30 dB in steps of 2 dB
Tolerance per gain step	± 2.0 dB max.
Gain variation **over normal operating temperature** **over extreme operating temperature**	 ± 1.5 dB ± 2.0 dB
Tolerance of gain over full bandwidth	± 2.0 dB max.
Delay	0.6 µs max., < 0.5 µs typ.
Far off selectivity	50 dB min.
ICP3 DL	≥ 62 dBm @ max.gain
Output power DL (@ -36 dBm IM	29 dBm typ. per carrier @ 2 carriers * 27 dBm min. per carrier @ 2 carriers **
Noise figure UL @ max. gain	7 dB max., < 6 dB typ.
ALC threshold UL **DL**	8 dBm typ. unless otherwise specified 32 dBm typ. unless otherwise specified
Return loss	15 dB min.
Power supply	230 Vac / 50 Hz Option: 110 Vac / 50 Hz; + 24 Vdc; - 48 Vdc
Power consumption	200 W max.
Built in test equipment	Current monitor, temperature
Environmental and Safety Specifications	see seperate leaflet for MIKOM outdoor cell enhancers according to ETS 300 019.

* @ normal temp. range: + 5° C ... + 40° C
** @ extreme temp. range: - 33° C ... + 50° C

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MIKOM
AN ALLEN TELECOM COMPANY

OPTICAL REMOTE UNIT WIDE BAND IN UL AND DL 400 MHz Applications

MOR200X

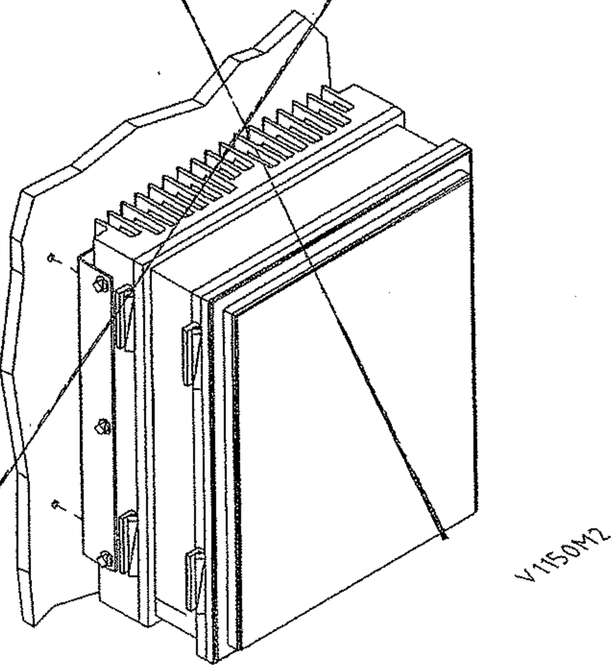
OPTICAL SPECIFICATIONS	MOR200X
Max. allowed optical loss Master / Remote	10 dB *
Required optical return loss	45 dB

* optical loss up to 12 dB with slightly degraded performance

MECHANICAL SPECIFICATIONS	MOR200X

The MOR200X is available in the G-cabinet with spacer and cover.

G-cabinet with spacer and cover	
Height, Width, Depth:	535 × 441 × 208 mm
Volume	< 51 litres
Weight	approx. 35 kg per unit



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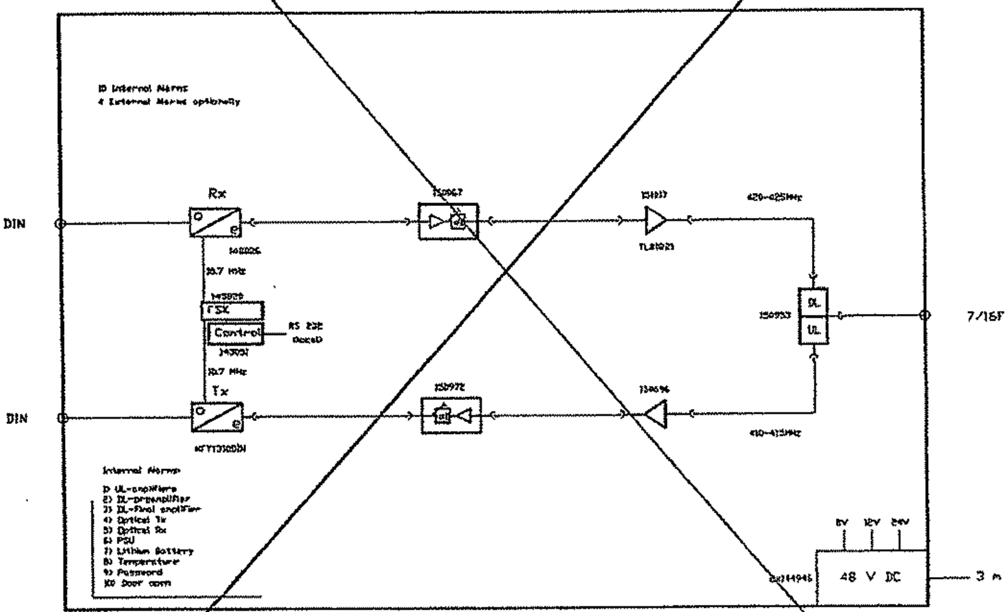
AN ALLEN TELECOM COMPANY

OPTICAL REMOTE UNIT WIDE BAND IN UL AND DL 400 MHz Applications

MOR200X

DESIGN PRINCIPLE — MOR200X



Schematic only!

OPTIONS — MOR200X

External Alarms	4 external alarms can be monitored via the repeater software

~~Attachment E – Proposed Omnidirectional Antenna Specification Sheet for 450 MHz Public Safety~~

BROADBAND

150/512 MHz

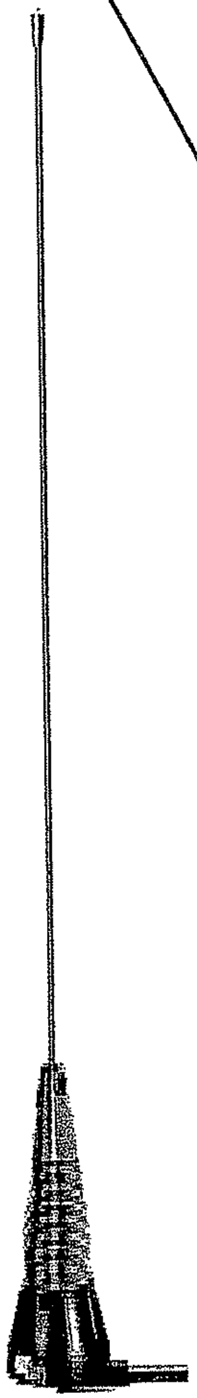
Mosaic®

Professional Quality, Low Profile Mount Broadband Quarter-wave Antenna

Model

ASPR7490 Series

Antenna Mounting Option



Broadband — designed to match wide frequency-ranging synthesized radio equipment

Durable — large, heavy duty stainless steel spring and whip assure long, trouble-free performance in rugged operating environments

Weatherproof — universal Motorola-compatible NMO mount provides moisture seal even when antenna is removed from the mount for car wash clearance

Long Life — durable black textured co-polyester base provides long-lasting operation

Modular Design — for stocking flexibility

ASPR7495
Low profile or Motorola conversion — no cable.

Specifications

Electrical	
Frequency Range	150-512 MHz
Gain	Unity (2 dBi)
VSWR	2:1
Power	150 Watts
Bandwidth	24 MHz (150-174 MHz) Over 100 MHz (406-512 MHz)
Impedance	50 ohms
Mechanical	
Whip Material	17-7PH stainless steel 0.125 inch (3.2 mm) diameter
Whip Length	16-3/8 inches (41.6 cm) at lowest frequency
Spring Material	Stainless steel
Mount Installation	Teflon™
Cable	17 ft (5.2 m), RG-58/U where furnished
Connector	Available separately

Component Combinations

To Create	Use
Trunk Lid Mount Antenna	ASPR7495 Antenna and K-721 Mount
Magnet Mount Antenna	ASPR7495 Antenna and K-220 Mount
Snap-in Mount Antenna	ASPR7495 Antenna and KL768 Mount

ASPR7490
Low profile 3/4 inch (19.1 mm) hole rooftop mount, with cable.

~~Attachment F – Average Link Budget for 800/450 MHz Public Safety Services~~

Parameter	800 Trunking (14 channels)	450 Trunking (8 channels)
UPLINK		
Mobile Unit TX (dBm)	30.00	33.00
Mobile Unit TX (Watts)	1.00	2.00
Mobile Antenna Gain (dBi)	0.00	0.00
Mobile EIRP (dBm)	30.00	33.00
Mobile EIRP (Watts)	1.00	2.00
Noise Power Spectral Density		
kT (dBm/Hz)	-174.00	-174.00
Interference Margin (dB)	3.00	3.00
Total Remote Unit Noise Figure (dB for 8 remotes)	15.00	15.00
Interference plus noise power spectral density (dBm)	-156.00	-156.00
SNR 9 dB	9.00	9.00
Spectral Bandwidth (kHz)	44.77	44.77
Processing Gain	0.00	0.00
Minimum Signal Level at Remote Unit (dBm)	-102.23	-102.23
Maximum Allowable Uplink Path Loss	132.23	135.23
DOWNLINK	—	—
Remote Unit TX (dBm)	17.00	23.00
Remote Unit TX (Watts)	0.05	0.20
Splitter Loss	-4.70	-4.70
Remote Unit Average Coax Length (ft)	120.00	120.00
Remote Unit Average Coax Loss	-3.86	-2.78
Remote Unit Antenna Gain (dBi)	0.00	0.00
Remote Unit EIRP (dBm)	8.44	15.52
Remote Unit EIRP (Watts)	0.01	0.04
Noise Power Spectral Density		
kT (dBm/Hz)	-174.00	-174.00
Interference Margin (dB)	3.00	3.00
Handset Noise Figure (dB)	8.00	8.00
Interference plus noise power spectral density (dBm)	-163.00	-163.00
SNR 9 dB or Eb/No 7 dB	9.00	9.00
Spectral Bandwidth (kHz)	44.77	43.98
Minimum Signal Level at Handset (dBm)	-109.23	-110.02
Maximum Allowable Downlink Pathloss (dBm)	126.23	133.02
Maximum Allowable Uplink Pathloss (dBm)	132.23	135.23
Additional Losses		
Body Loss (dB)	-1.00	-1.00
Vehicle Penetration Losses (dB)	-8.00	-8.00
Fast Fade Margin (dB)	-4.00	-4.00
Slow Fade Margin (dB)	-5.00	-5.00
Distance from Remote Unit (m)	800.00	800.00
Free Space Path Loss from Remote Unit (dB)	78.27	73.27
Total Path Loss for Distance from Remote Unit w/Losses	96.27	91.27
In-Vehicle Expected Mobile Unit RSSI (dBm)	-88.00	-76.00
On-street Expected Mobile Unit RSSI (dBm)	-80.00	-68.00

Attachment G – Proposed MIDAS Equipment and Antenna Locations

Phase 1

Number	Remote Unit	Tunnel	Antenna 1	Coax 1 (ft)	Antenna 2	Coax 2 (ft)	Antenna 3	Coax 3 (ft)
1	RU-90-01A	Ramp L	A-90-01A1	30				
2	RU-90-01B	Ramp L	A-90-01B1	30				
3	RU-90-09A	Ramp D	A-90-09A1	120				
4	RU-90-09B	Ramp D	A-90-09B1	120				
5	RU-90-08A	I-90W/Ramp F, I-90E	A-90-08A1	100	A-90-08A2	100		
6	RU-90-08B	I-90W/Ramp F, I-90E	A-90-08B1	100	A-90-08B2	100		
7	RU-90-07A	Ramp L, HOV E	A-90-07A1	50	A-90-07A2	120		
8	RU-90-07B	Ramp L, HOV E	A-90-07B1	50	A-90-07B2	120		
9	RU-90-13A	I-90 W, Ramp D	A-90-13A1	30	A-90-13A2	100		
10	RU-90-13B	I-90 W, Ramp D	A-90-13B1	30	A-90-13B2	100		
11	RU-90-17A	I-90 E, Ramp L/HOV E	A-90-17A1	30	A-90-17A2	30		
12	RU-90-17B	I-90 E, Ramp L/HOV E	A-90-17B1	30	A-90-17B2	30		
13	RU-90-21A	1-90 W, Ramp D, I-90 E	A-90-21A1	30	A-90-21A2	30	A-90-21A3	120
14	RU-90-21B	1-90 W, Ramp D, I-90 E	A-90-21B1	30	A-90-21B2	30	A-90-21B3	120
15	RU-90-26A	Ramp L, Ramp I, HOV E	A-90-26A1	50	A-90-26A2	30	A-90-26A3	120
16	RU-90-26B	Ramp L, Ramp I, HOV E	A-90-26B1	50	A-90-26B2	30	A-90-26B3	120
17	RU-90-23A	I-90 W, I-90 E	A-90-23A1	50	A-90-23A2	50		
18	RU-90-23B	I-90 W, I-90 E	A-90-23B1	50	A-90-23B2	50		
19	RU-90-33A	Ramp A, HOV E	A-90-33A1	50	A-90-33A2	50		
20	RU-90-33B	Ramp A, HOV E	A-90-33B1	75	A-90-33B2	75		
21	RU-90-36A	Ramp F, I-90 W	A-90-36A1	75				
22	RU-90-36B	Ramp F, I-90 W	A-90-36B1	75				
23	RU-90-37A	I-90 W, I-90 E, HOV E	A-90-37A1	30				
24	RU-90-37B	I-90 W, I-90 E, HOV E	A-90-37B1	30				

Phase 2

Number	Remote Unit	Tunnel	Antenna 1	Coax 1 (ft)	Antenna 2	Coax 2 (ft)
1	RU-CANB-385A	CANB, Ramp C	A-CANB-385A1	30	A-CANB-385A2	120
2	RU-CANB-385B	CANB, Ramp C	A-CANB-385B1	30	A-CANB-385B2	120
3	RU-CANB-103A	CANB, Ramp C	A-CANB-103A1	30	A-CANB-103A2	120
4	RU-CANB-103B	CANB, Ramp C	A-CANB-103B1	30	A-CANB-103B2	120
5	RU-CANB-18A	CANB	A-CANB-18A1	30		
6	RU-CANB-18B	CANB	A-CANB-18B1	30		
7	RU-CANB-12A	CANB, Ramp A-CN/R-T	A-CANB-12A1	30	A-CANB-12A2	120
8	RU-CANB-12B	CANB, Ramp A-CN/R-T	A-CANB-12B1	30	A-CANB-12B2	120
9	RU-CANB-04A	CANB, Ramp CN-SA	A-CANB-04A1	30	A-CANB-04A2	120
10	RU-CANB-04B	CANB, Ramp CN-SA	A-CANB-04B1	30	A-CANB-04B2	120
11	RU-CANB-06A	CANB	A-CANB-06A1	30		
12	RU-CANB-06B	CANB	A-CANB-06B1	30		
13	RU-CSSA-01A	Ramp CS-SA, CS-CT	A-CSSA-01A1	100	A-CSSA-01A2	100
14	RU-CSSA-01B	Ramp CS-SA, CS-CT	A-CSSA-01B1	100	A-CSSA-01B2	100
15	RU- SACT-02A	Ramp SA-CT	A- SACT-021	100	A- SACT-022	100
16	RU- SACT-02B	Ramp SA-CT	A- SACT-021	100	A- SACT-022	100
17	RU-CSCT-05A	Ramp CS-CT, SA-CS	A-CSCT-05A1	100	A-CSCT-05A2	100
18	RU-CSCT-05B	Ramp CS-CT, SA-CS	A-CSCT-05B1	100	A-CSCT-05B2	100
19	RU-STSA-06A	Ramp ST-SA, ST-S	A-STSA-06A1	100	A-STSA-06A2	100
20	RU-STSA-06B	Ramp ST-SA, ST-S	A-STSA-06B1	100	A-STSA-06B2	100
21	RU-STS-07A	Ramp ST-S	A-STS-07A1	100	A-STS-07A2	100
22	RU-STS-07B	Ramp ST-S	A-STS-07B1	100	A-STS-07B2	100
23	RU-STSA-PR2A	Ramp ST-SA, ST-CN	A-STSA-PR2A1	100	A-STSA-PR2A2	100
24	RU-STSA-PR2B	Ramp ST-SA, ST-CN	A-STSA-PR2B1	100	A-STSA-PR2B2	100
25	RU-STCN-09B	Ramps ST-CN, SA-CN	A-STCN-09B1	100	A-STCN-09B2	100
26	RU-STCN-09A	Ramps ST-CN, SA-CN	A-STCN-09A1	100	A-STCN-09A2	100
27	RU-CANB-10A	CANB, CASB	A-CANB-10A1	100	A-CANB-10A2	100
28	RU-CANB-10B	CANB, CASB	A-CANB-10B1	100	A-CANB-10B2	100
29	RU-SACN-CPA	Ramp SA-CN	A-SACN-CPA1	50		
30	RU-SACN-CPB	Ramp SA-CN	A-SACN-CPB1	50		
31	RU-CASB-EEA	CANB, CASB	A-CASB-EEA1	50	A-CASB-EEA2	50
32	RU-CASB-EEB	CANB, CASB	A-CASB-EEB1	50	A-CASB-EEB2	50
33	RU-LCS-01A	Ramp LCS	A-LCS-01A1	50		
34	RU-LCS-01B	Ramp LCS	A-LCS-01B1	50		
35	RU-LCS-02A	Ramp LCS	A-LCS-02A1	50		
36	RU-LCS-02B	Ramp LCS	A-LCS-02B1	50		
37	RU-LCS-03A	Ramp LCS	A-LCS-03A1	50		
38	RU-LCS-03B	Ramp LCS	A-LCS-03B1	50		

Phase 3

Number	Remote Unit	Tunnel	Antenna 1	Coax 1 (ft)	Antenna 2	Coax 2 (ft)	Antenna 3	Coax 3 (ft)
1	RU-CASB-01A	I-90 Collector, CASB	A-CASB-01A1	30	A-CASB-01A2	120		
2	RU-CASB-01B	I-90 Collector, CASB	A-CASB-01B1	30	A-CASB-01B2	120		
3	RU-190C-03A	I-90 Collector, CASB	A-190C-03A1	30	A-190C-03A2	120		
4	RU-190C-03B	I-90 Collector, CASB	A-190C-03B1	30	A-190C-03B2	120		
5	RU-190C-06A	I-90 Collector, CASB	A-190C-06A1	30	A-190C-06A2	50	A-190C-06A3	120
6	RU-190C-06B	I-90 Collector, CASB	A-190C-06B1	30	A-190C-06B2	50	A-190C-06B3	120
7	RU-RRT-19A	Ramp R-T, CASB	A-RRT-19A1	50	A-RRT-19A2	120		
8	RU-RRT-19B	Ramp R-T, CASB	A-RRT-19B1	50	A-RRT-19B2	120		
9	RU-RRR-20A	1-90 Collector, Ramp R-R	A-RRR-20A1	120				
10	RU-RRR-20B	1-90 Collector, Ramp R-R	A-RRR-20B1	120				
11	RU-CASB-10A	Ramp CS-P, CASB	A-CASB-10A1	30	A-CASB-10A2	50		
12	RU-CASB-10B	Ramp CS-P, CASB	A-CASB-10B1	30	A-CASB-10B2	50		
13	RU-CASB-09A	Ramp A-CN/R-T, CANB	A-CASB-09A1	30	A-CASB-09A2	120		
14	RU-CASB-09B	Ramp A-CN/R-T, CANB	A-CASB-09B1	30	A-CASB-09B2	120		
15	RU-CASB-03A	CASB	A-CASB-03A1	30				
16	RU-CASB-03B	CASB	A-CASB-03B1	30				
17	RU-CASB-05A	CASB						
18	RU-CASB-05B	CASB						